

LIBRARY
National Academy of Sciences

SCIENTIFIC AMERICAN SUPPLEMENT

Copyright 1915 by Munn & Co., Inc.

VOLUME LXXIX]
NUMBER 2044

NEW YORK, MARCH 6, 1915

[10 CENTS A COPY
\$5.00 A YEAR



Hauling out a tree stump by a lifting derrick.



Sawing snags into sections as they are lifted from the water.

HOW THE GOVERNMENT KEEPS OUR RIVERS FREE FROM OBSTRUCTIONS.—[See page 149.]

Personal Biologic Examinations*

The Condition of Adequate Medical and Scientific Conduct of Life

By George M. Gould, M.D.

THE ranchman has his annual round-up; the merchant his yearly account of stock and balancing of books; the machinist gives his engine a thorough going-over at regular intervals; every military organization has its reviews and inspections, every government its budgets—indeed, every financial hair of the commercial head is noted, and not a sparrow of the hunter. Success, falls to the ground unnumbered; those that do not fall are even more accurately numbered. But it is not so concerning the one piece of mechanism that conditions all these things, and that is the most valuable of all earthly possessions—the human body. For all practical consideration a man's body is his life, and yet civilization has come so far without any systematization of the business and mechanics of the entire single and personal life. The science of bodily living in its complete extent still awaits its discoverer. Numberless philosophers treating of the conduct of life have soared in superficial inexactness and easy generality over the heads and hungers of the individual liver, but they have utterly failed to formulate the physiologic and pathologic conditions of success and failure. All the biologic and medical special sciences have struggled toward an unreachd unity; all are simple rays, as it were, awaiting the lens of a focalizing intelligence to illumine the concrete image of our total physical appearance here. War has devised a rough and crude system of physical examinations for the would-be soldier; insurance companies have more accurately examined the bodies and life-prospects of their policyholders to estimate their financial risks; through the Bertillon system, criminology has still more perfectly fixed the anatomic measuring of the bodies of the law-breakers; the Amherst and Harvard examinations have looked into the muscular functions of a few students for four years of their lives; the psychophysics laboratory has measured a few neurologic reactions; the medical practitioner has found out a few ways of reaching backward to the etiology of some single diseases; a few hundred school children have been subjected to some tests as to growth and the influence upon organization of poverty and wealth. But all these, I believe, are sporadic and ineffectual hints of a coming science of man, based upon a thorough-going and repetitive system of physiologic and pathologic examinations which will ultimately give us a genuine and all-comprising science of anthropology based upon all the data, morphologic, physiologic, and pathologic, of the entire individual life. Prophecy and prognosis are based upon a thorough knowledge of the past and present fact, a rigid understanding in a scientific sense of the evolution of the organism and of its present departures from a normal standard. For his children a foresighted man must wish such an accounting, such a prophecy and prognosis; and 'as to himself every intelligent adult, when he awakens to scientific consciousness, must try to look forward through the years, and reckon up his powers and possibilities of life. This most important function of prevision has heretofore been left to the gypsies, the palmists, the astrologists, and the clairvoyants! Is it a wise way for science to leave the individual struggler, unconscious and ignorant of his own body and its fateful laws, incapable of learning the scattered and un-unified half-sciences blindly converging to some far-off unity of mutual helpfulness and life? The crowning work of scientists is to turn science into prescience. The unification of the sciences dealing with the conduct of life; the making practical and useful our knowledge of the individual organism; and lastly to establish a scientific prescience—such are the ideals of a living anthropology.

Is it not at once plain that these ideals can be realized only by a system of periodic examinations and records made every year or every five years, throughout the life of the individual organism? Such a system of records may be held generally to comprise the following elements:

1. *The Hereditary Datum.*—The endowment at birth, the influence of heredity, must in every way govern and condition the development of the organism, and modify every reaction to environment. It is wise, therefore, in all ways possible to fix, at the opening of life, what is this datum of inheritance. Nationality, ancestral and genealogic histories, craniology, cerebriology,

etc., help to make up the estimate of this one factor.

2. *The Development and Historic Record.*—Especially during the period of growth—childhood and adolescence—should the space between the annual or quinquennial systematic examinations be historically epitomized. The strains, work, illness, and tasks conquered or incomplete, are surely a necessary part of the life-chronicle.

3. *The Morphologic or Anthropometric Examination is Fundamental.*—In this the Bertillon system, modified, perfected, and expanded, or something similar, should form the basis of such a system of physical measurements, descriptions, and records, statistic and graphic, that any future variation of the organism would be detected in later examinations; and thus would be preserved the morphologic picture of the individual for the whole life.

4. *The Physiologic Record* would include the testing and tabulation of all the significant reactions and functions. These would be made up of all necessary dynamic tests of the muscular system; of statements of accurately observed metabolic and nutritional functions; the reactions and reflexes of each of the special senses, and of those of the neurologic and psychophysics systems. The profound influence of habits, both positive and negative, innocent or harmful, should also be remembered.

5. *The Psychic or Intellectual Datum* is one too carelessly ignored in scientific and anthropologic studies. The fundamental qualities of character, disposition, memory, sentiment, religion, reason, morality, education, etc., are powerful influences acting upon and reacting to the environment and to disease, and if they are left out of the count a most valuable determinant of scientific prescience is lost.

6. *The Pathologic Element* is one heretofore almost or utterly ignored in anthropologic studies, and in instructions as to the conduct of life. The profession should urge its profound importance. The examinations at stated periods should in large part consist of the records of the findings of expert medical specialists secured by all the arts and instruments of diagnosis at their command. All departures from health and normality that indicate pathologic results or tendencies in any organ, or in the organism as a whole, are absolute conditions of estimate as to present powers or prospects. One is almost inclined to think that the savings in medicolegal cases, by such a system of examinations, would defray the expenses of making them. Some time ago a railway company, after several years of legal proceedings, was forced to pay a man \$10,000 damages for intracranial hemorrhage said to have been caused by a fall from a car. When the man died there was found in his brain a bullet which had been received 25 years previously in the Franco-Prussian war, and this had produced all the non-feigned symptoms for which the railway had to pay.

7. *The Factor of Heredity* closes the circle, with the possibility of making more accurate the knowledge of the transmission of the individual endowment to the child. Successive generations are but the completion and extension of a single personality. The family is the realization of the incomplete individual.

Leaving out of consideration the questions of the onerousness of the task proposed, and the apparent impossibility of carrying out so many observations, one may ask as to the feasibility of keeping the records of such a series. The answer to this query points to the most remarkable plasticity and adaptability of the modern plan of record-making by the card system, with its ever variable and extensible use of loose leaflets or cards of different colors, numbers, ear-marks, sizes, etc. Photography, the kromescop, the phonograph, the instruments of the physiologic and psychophysics laboratories, and those of every specialist in medicine, make it easily possible to condense the chronicles of all tests and examinations in an inexpensive and effective way. The post-mortem records, and the preservation of the brains, and, perhaps, of the skulls of the subjects, would supplement the work.

As has been intimated, we already have the beginnings, the sporadic attempts, and detached parts of such a system of examinations. The Bertillon criminal records of the police bureaus, the anthropometric data of military examinations, the results of athletic and gymnasium tests, those of psychophysics laboratories, the medical examinations of school children, and those especially of life insurance companies, etc.—all these indicate the thought, labor and expense which civilization

is giving to the problem. But the most important of all contributions might be the case-books, hospital records, and patients' histories of physicians. Hardly a tithe of the precious material, however, is utilized. The waste of biologic data—wasted because not systematized and unified—in the lost records of physicians is appalling. The most valuable books in the world are the oldest city directories, scientific statistic records, etc., and more valuable still would in future years be the present day case books of scientific physicians, if they were well kept and illumined by statistical and scientific judgment. We now dump them into the pulp-mill.

Is it a foolish dream, is it an unrealizable ideal, that all these things might be preserved, and rendered of use to science and humanity by some institution carried on by the Government, by a university, or by a union of scientific and medical men, whereby the records of individual lives might be made so frequently, so continuously, and so scientifically that we should at least gather the inductive data for a genuine science of anthropology, pathology, and ethical biology? If governments could be prevailed upon to devote to this work one tenth the money now squandered in war; if legislators could be prevailed upon to give to it a small proportion of their stealings and political plunderings; if a fraction of the money poured into the pockets of the ward and city bosses could be got; if a small percentage of that spent on comic opera could be shunted this way! If these are idle dreamings is it not perfectly possible that in future ages some wise legislator of some civilized government may convince his fellows that not only is this the duty of the national administration, but that the very beginnings of the system are already in operation in the national census-taking? In this the mechanism is really inaugurated, and needs but the inclusion of the civil service examination, the soldiers' entrance tests, and the governmental pensioners' medical examinations, to bring it a long way toward perfection. With the plan once determined upon, and the brain once found to gather the haphazard and discrete parts to an organic unity, but little additional expense would be incurred over that now spent in the separate systems. Indeed, the scheme itself is only an extended and a perfected bureau of vital statistics. Once such co-operation were started, the city and State with their criminologic statistics, the insurance companies with their accurate vital and pathologic records, and especially the medical profession with its systematized records of individual and social morbidity, and many other agencies, would be drawn into co-operation, and the bases of a truly inductive and physiologic science of civilization would begin to be laid.

While we wait for that millennial palace of science we physicians need not be idle—nay, we may be at work in the quarries. Our first duty is to reorganize, systematize, and make scientific our case-books and recordings of patients' histories. Let us study this great and neglected art so that these most precious fruits of our life work shall not end in the pulp mill. The lack of literary workmanship in making and keeping our records of disease is altogether deplorable. What is left to science of the life work of a million physicians whose business has been with the most precious biologic facts of the world? Can we not perfect some bridge whereby the results of our life labors can be carried over the stream of death and become the property of general biologic and pathologic science?

Surely then, our second duty is to make our science prescient, by means of the repeated examination at stated intervals of those patients whom we can convince of the necessity and wisdom of such a proceeding. It is a shame of medicine that in the one department of our science which we are most foolishly inclined to look down on with too much superciliousness, its practitioners have outrun us. The dentists have long recognized the need of periodic examinations of the special organ, regardless of symptoms, and they have at last driven the knowledge into the minds of their patients. Thousands of patients have their teeth periodically examined for beginning needs and diseases or to prevent them. If this be wise as regards the teeth, how infinitely wiser it would be as regards the kidneys, the eyes, the heart, arteries, etc., and the person as a whole. It is the shame of medicine and the basis of quackery, this symptom treating and symptom killing. What a horrible fact—this of the vogue of the pain deadeners! Millions of dollars are capitalized in the business, and half or three fourths of the work of

* Presented to the Section on Practice of Medicine, at the fifty-first annual meeting of the American Medical Association, held at Atlantic City, N. J., June 5th to 8th, 1900, and published in the *Journal of the American Medical Association*, July 21st, 1900.

our lives is devoted to the mere stopping or deadening of symptoms. But, as we all know, true medicine is to stop the cause of symptoms, to prevent the symptoms from ever arising. For many years in my specialty, I have been begging that biennial ocular examinations should be made, regardless of "no trouble," regardless of "perfect satisfaction." Absence of symptoms is no evidence whatever of absence of disease. No eye should ever be left over two years without re-examination. No spectacles can remain correct two years, because no eye ever preserves the same refraction, balance, and powers, for that period of time.

And what good also is the enucleated eyeball, or any piece of dead tissue, in the hands of the pathologist? Certainly only to prevent other living eyes and organs from becoming as these dead ones have. True pathology is surely knowledge of the disease in the making. The pathologist's final problem is to prevent pathologic specimens from ever coming into his hands. *Qua* pathologist he must commit scientific suicide. Most of our fashionable pathology is the paleontology, not the biology, of disease; but was it not said of old, that it is better to be a living dog than a dead lion? How is disease in the making ever to be discovered except by examinations, continuous observation, of the living supposably-well organism?

Is it not even true of living disease that one half the patients seen by the doctor are seen far too late? For paresis, locomotor ataxia, etc., and for many psychic diseases we do nothing, because we recognize their existence so late that nothing can be done. Had they been seen earlier injury could have been prevented. Surely in more than 25 per cent of my patients many years or whole lifetimes of suffering and disease could have been obviated. It is doubtless true in general medicine. All good medicine inevitably tends to become preventive medicine; all good physicians labor to stop disease before it arrives. The whole ingenuity of the trained diagnostician is now expended on the problem of the earlier symptom. He is the greatest discoverer who finds the presymptom, or the symptom of the symptom; the greatest therapist is he who cures before the disease exists, he who starves the bacillus to death, he who stops the evil habit, thus preventing the malfunction that becomes organic disease. The best cat is the one that kills the rat that eats the malt that lies in the house that Jack built. It is a truism that gout exists in the patient's system long before it causes a twinge of pain; the kidneys are ruined before the slightest subjective system is manifest; there may be heart changes indicating the existence of nephritis, which a single uranalysis may not detect; arteriosclerosis may be present prior to subjective symptoms, and the objective examination would detect it; there may be unsuspected diabetes without symptoms until examination of the urine reveals it—even with our crude science early uranalysis of the apparently well would often reveal the hidden evil at work sapping and mining toward the vital centers. Every oculist has often discovered albuminuria before the general physician suspected it. There are a hundred known intimations and auras of oncoming disease, but there are a thousand undiscovered ones, presymptoms, advance scouts and forerunners, to be learned when the slight and unconscious departures from normality are studied by examinations of the supposedly well. Pathogenesis, not therapeutics, is the ultimate study of all medicine. And all pathogenesis is by no means running bugs to their holes: the greater number of life wasting diseases are not bacterial in origin; and even the growth of the bacterial diseases depends on the soil in which they are sown.

I picture to myself a new field of work opening out before the poor plundered general practitioner. It must often seem to him that as a general he has been stripped of both army and enemy. One by one the specialists have robbed him until he has left hardly a soldier for a patient. The surgeon first took almost half of his army, and now threatens to relieve him of Colonels Appendicitis and Typhoid, and heaven knows of how many more officers which he formerly considered his very own. Then the aurist, the oculist, and the rhinologist deprived him of his special senses, and the laryngologist rendered him aphonic. If the obstetrician and gynecologist left him one or two of all his women folk, the rest were man and the neurologist soon alienated the affection of these hysterics—and they lived unhappily ever after. The pediatricist stole his babies and the psychiatrist his mind; and, lastly, the gastrologist will not allow him to have all to himself even a simple stomach ache.

The truth seems to be that of all the specialists the generalist has been squeezed into the narrowest specialty, and the surgeon is grasping avidly at his one or two remaining comforts. Even the diseases of the lungs, stomach, and kidneys are now claimed and we may soon expect to see such advertisements in the re-

ligious and daily newspapers as: "A new operation for neurasthenia; craniotomy for unselfishness; preventive inoculations in case of threatened breach of promise; vaccinations for antivivisectionists; damaged heart-valves surgically repaired while you wait; kidneys transplanted immediately following the next electrocution; complete maturation of the artificially fertilized ovum in our new twenty-first century incubator."

The family physician's function seems to be fast becoming that of adviser-in-general and referrer-to-others; the "last straw" is that ethics will not permit these others to divide their fees with him. Nothing in fact is left to him except to have permanent anorexia and to move to a climate in which house and clothing are not necessary—Porto Rico and the Philippines, for example—providentially supplied, without doubt, for this and similar tariff purposes.

But seriously, have we not gone too far with our specialism, and are we not thereby in danger of losing the co-ordinating sense and oversight of the organism as a whole? The specialist cannot be dispensed with. By his aid and through his accuracy medicine must progress; but neither should the generalist be squeezed aside. He is even more necessary. It is his duty to teach his under officers, the specialists, their proper places, and by his sane and large grasp of all the facts supplied by these subalterns, by his co-ordination of the work of each and of all with his own overlook of organism and life as a whole, he brings cosmos out of chaos, and organic unity out of hundred-eyed and selfish diversity. The specialist is fatally inclined to treat the disease; to the generalist must be left the far more important treatment of the patient.

It may seem hard and impertinent to say to an audience of generalists that the generalists have been robbed because of their own fault and negligence. The so-called stealings of the specialists are in reality helpful and if rightly understood they leave the generalist his proper work. Life, it has been said, is made up of little things; and yet life itself is not a little thing. So it is with health, fullness of years, and utilization of powers; they all depend, medically and physiologically, upon little things, and yet compositely they are "the greatest thing in the world." In the vogue of the specialist, the generalist is more than ever needed. If the aristocrats have usurped power, there is the chance and demand for a powerful king. The specialists are, or may be made, the assistants of the general physician, who needs their help and all the data they can supply, and whose supreme function it is to fuse the whole to a higher unity and to establish the secret relations in reality existing in all. There is no specialist who is not willing and glad to make full and systematic reports to the general physician of all his findings. It is his duty to the patient and it is the specialist's self-interest to do it well. He is not so stupid as to offend the referrer of patients. In this function the generalist has the whip-hand—and he should use it, at times.

And thus it happens that the desirable system of personal biologic tests sketched need not await the action of government, the university department, the city or State institute, the union of anthropologic societies, or the anthropometric and pathologic institution founded by private endowment. Let us earnestly pray and work for any or all these things; but in the meantime much may be done by medical men and societies to prepare for the larger and more perfect outworking of the scheme—may much may be done toward the realization of its more distinctively medical features.

Based upon the fact actually felt by every physician, that a series of systematized periodic examinations of patients apparently well would often reveal beginning diseases, prevent future illnesses and increase the vital values of life, every one can prevail upon certain patients, students or members of his family, to undergo the necessary tests. The more intellectual and well-to-do citizens will soon realize the self-evident value of such work, and not only submit to it for themselves and children, but will be willing to pay an annual fee for the service. Specialists will be willing to contribute their results. The examinations need be only of the more fundamental and simple factors at first until the good-will, machinery, funds, and recognition of the significance and usefulness of the work grow.

In several ways these examinations themselves are the means of a striking self-education of the physician:

1. In systematizing and perfecting a method of record-keeping there is a subjectively psychological as well as an objectively scientific result of inestimable good. It is a sort of liberal education. To adapt and perfect the card system to this useful end; to summarize the results of all diagnostic methods; to formulate prognoses; to classify and epitomize so that the whole shall look to the personal advantage, as well as toward the progress of preventive medicine; and finally, to dovetail the combined result into general biologic science and to clarify the laws of heredity; all of this is labor

worthy of the wisest selfishness and the best intellectuality.

2. In rendering accurate and mathematical all the known and recognized methods of medical testings, there is much to be learned. It is in catching sight of the forerunning indication of disease, the symptom of the symptom, the functional beginnings of organic abnormalism, that a great deal of progress lies. Who, e. g., as yet, measures the blow or stimulus in taking the patellar tendon and other reflexes, with machine-shop accuracy, also the resultant excursion or reaction, chronicling same in his notes, with absolute or approximate precision?

3. In the excursions into the border land, but still closely related, domains of cerebrology, craniology, psychophysics, criminology, sociology, public hygiene, and all the rest—in learning to make these tests, and chronicle the results required in these studies, one enlarges the range of his subjects, broadens his personal and scientific outlook, in a word annexes with justifiable imperialism and expansion, the adjacent territories of his special science. Each gives his light, and, as in all beneficence, by giving, each increases his own as well as the general illumination. The stars go out but the day dawns.

Cultivation of Living Tissues Outside the Body*

THE story of the cultivation of tissues outside of the living body has already lost much of its novelty. Though we can still easily count the time in terms of months rather than years, since the first demonstration of the development in vitro of isolated fragments made up of connective tissue cells, the fact has been established so conclusively and the technic developed so successfully that the cultivation of tissues in this way has already become a familiar practice in many laboratories. It is sometimes said that familiarity breeds contempt; but it may be wholesome at times to renew our acquaintance with the details of well-known scientific procedures and learn their present status. This is particularly desirable in the case of those persons who little realize the persistence and energy, the patience and forethought, which may of the permanent acquisitions of science demand on the part of investigators. We who share the results all too frequently fail to understand the laborious process by which success is attained. In this field the advice once given to an ambitious medical student may be reiterated: "Success is neither luck nor pull, but the longest, toughest job you ever tackled."

Not long ago Carrel¹ of the Rockefeller Institute for Medical Research called attention to the condition of a strain of connective tissue kept outside of the organism in a condition of permanent life. It was derived originally from a piece of heart extirpated from a chick embryo. The fragment pulsed for 104 days, and gave rise to a large number of connective tissue cells which have since multiplied actively. The strain, after having undergone 358 passages, reached the twenty-ninth month of its life in vitro some time ago. It now appears that the proliferating power has in no wise diminished. During the third year of independent life of the connective tissue we are confronted with the remarkable fact that it shows greater activity than at the beginning of that period, and is no longer subject to the influence of time. Carrel remarks that if we exclude accidents, connective tissue cells, like colonies of Infusoria, may proliferate indefinitely.

In this connection it is interesting to note some recent results for human tissues reported from the same laboratory. It has been possible, for example, to keep human fetal tissue, derived from fresh cadavers, in a condition of independent life for several generations.² This has led to the attempt to cultivate human sarcomatous tissue in the same manner. The first essay in the direction of growing human malignant tumor in vitro was made in 1911 by Carrel and Burrows.³ The tissues were kept in a condition of survival for a few days, but no real cultures were obtained. Losee and Ebeling⁴ have now succeeded in keeping cultures of such tissue in a condition of active life in vitro for several generations. Their method may, therefore, prove of value in the study of the growth of human malignant tumor.

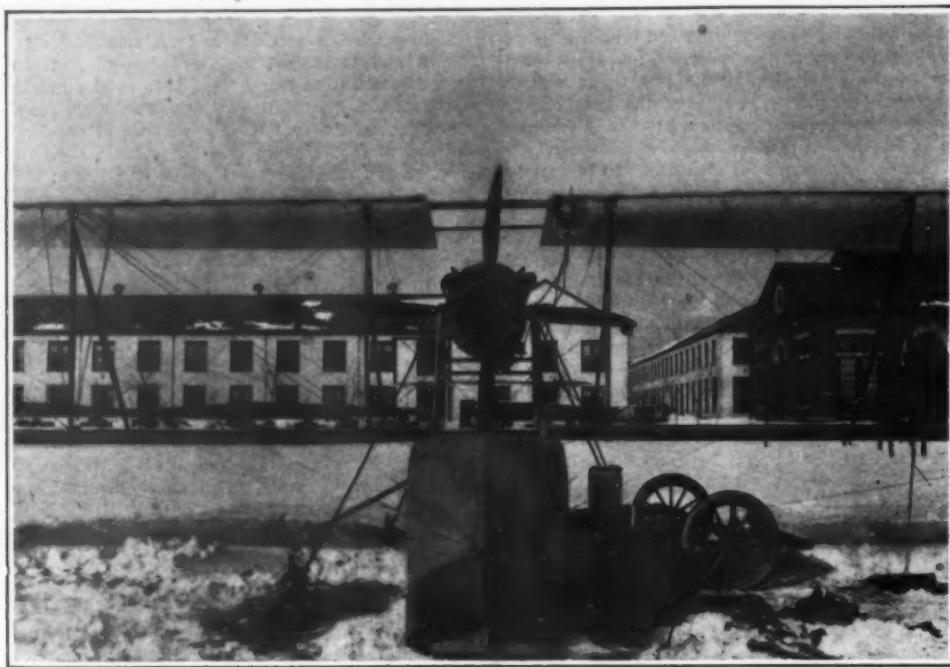
* From the *Journal of the American Medical Association*.

¹ Carrel, Alexis: Present Condition of a Strain of Connective Tissue Twenty-eight Months Old, *Jour. Exper. Med.*, 1914, xx, 1; see also *Jour. Exper. Med.*, 1912, xv, 516. Ebeling, A.: *Ibid.*, 1913, xvii, 273. Carrel, Alexis: *Ibid.*, 1913, xviii, 287.

² Losee, J. R., and Ebeling, A. H.: *Jour. Exper. Med.*, 1914, xix, 593.

³ Carrel, Alexis, and Burrows, M. T.: *Jour. Exper. Med.*, 1911, xlii, 387.

⁴ Losee, J. R., and Ebeling, A. H.: The Cultivation of Human Sarcomatous Tissue in vitro, *Jour. Exper. Med.*, 1914, xx, 140.



The full-sized experimental flying-boat with hollow V-shaped hull, at Washington Navy Yard.

Experiments With Flying Boat Hulls

By Carl Hawes Butman

THE first report of the sub-committee on hydromechanics in relation to aeronautics just published by the Langley Aerodynamical Laboratory of the Smithsonian Institution, deals with the results of a series of experiments with flying boat hulls. The experiments were conducted at the Model Basin in the Washington navy

yard under the direction of Naval Constructor H. C. Richardson, for the purpose of determining the resistance of several models at "displacements corresponding to speeds," on the water, and the resistances "submerged," as a means of approximating their total head resistances in air, and of determining an approximate "coefficient of fineness of form."

The experiments proved particularly successful. A form of improved hull has been derived which will probably supersede the present type of naval hydro-

aeroplane hulls. This model appears to have certain advantages over the types now in use, possessing less resistance on the surface of the water, and less head resistance in the air under similar conditions.

The model hulls used in the experiment were of the ventilated step type, one-ninth actual size, except one a quarter-size model of the original "Curtiss" pontoon. Plots of the model runs were made by the investigators.



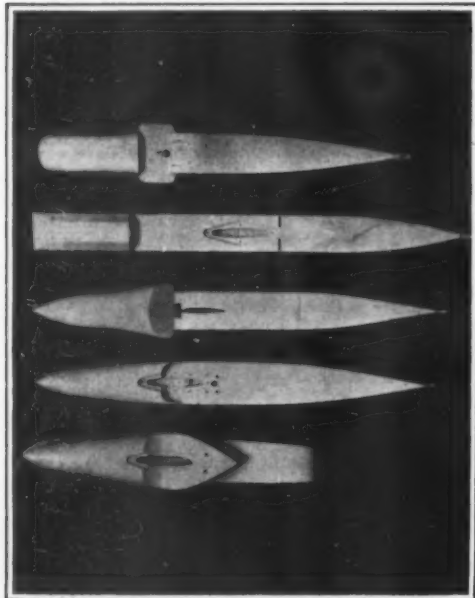
Bow views of five models.

showing: net resistance, derived effective horse-power, and change of level. The resistance curves were determined by towing the models in the basin at "displacements corresponding to speeds," with a set trim, but free to rise or fall under the influence of suction or planing. The change of level curves show how the planing effect changes the draft at each condition. The models were towed under conditions representing a full load of 2,200 pounds, with the assumption that the get-away occurs at a speed of 45 miles per hour. From the curves it is obvious that suction is present at low speeds, succeeded by a condition in which the model runs hard, followed by a period during which the model begins to plane; just before planing is effected, the slope of the curve lessens rapidly, and when planing is established the resistance falls off sharply with one exception.

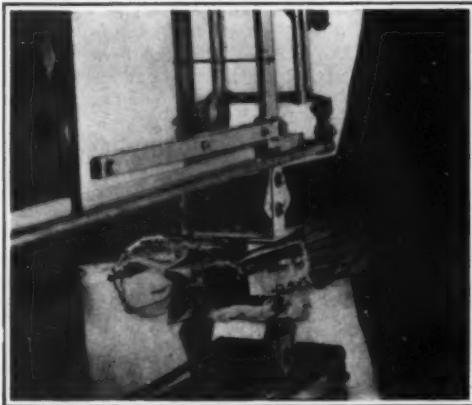
A model was designed to obviate the defects of the flat scow-bow type, by introducing the V type bottom

showing: net resistance, derived effective horse-power, and change of level. The resistance curves were determined by towing the models in the basin at "displacements corresponding to speeds," with a set trim, but free to rise or fall under the influence of suction or planing. The change of level curves show how the planing effect changes the draft at each condition. The models were towed under conditions representing a full load of 2,200 pounds, with the assumption that the get-away occurs at a speed of 45 miles per hour. From the curves it is obvious that suction is present at low speeds, succeeded by a condition in which the model runs hard, followed by a period during which the model begins to plane; just before planing is effected, the slope of the curve lessens rapidly, and when planing is established the resistance falls off sharply with one exception.

A model was designed to obviate the defects of the flat scow-bow type, by introducing the V type bottom



Plan views of five models.



Spray made by a model at 5.5 miles per hour.

for parting the water rather than forcing it aside. An earlier model of the V type caused a great amount of spray, and to overcome this the V section was made flat but as this only increased the spray, the V sections were made hollow which brought about the desired result, holding the spray down, increasing the planing effect, and reducing the resistance.

Confirmation of the behavior of the models has been fairly well established by the actual performance of full sized machines. Actual experiments with a full sized machine show that the improved hollowed V section hull is very desirable on account of the good landing qualities.

From the experiments carried on it has been determined that the step should be close to the center of gravity, to eliminate the nosing tendency, to facilitate change of trim while planing and to avoid a change of balance when getting away or landing; hollow V sections decrease the spray, cut the water easier and cleaner, plane better, and reduce the shock of landing or running through rough water, practically eliminating the necessity of shock absorbers. A shallow step seems to be sufficient, but ventilation back of the step is essential to facilitate the breaking of suction effects. The bottom forward of the step should be inclined to the axis of the machine but not so greatly as to cause the machine to plane before the controls are effective. The bottom abaft the step should rise strongly to favor a steepening of the planing bow before the elimination of suction, and to get the tail well clear when planing begins.

Diagrams were also made to show the logarithmic plots of the models when submerged one foot and towed at speeds up to 15 knots. From these plots it is seen that the resistances of the models closely approximate the law of the square of the speeds. The head resistances of the full sized machines were calculated by three methods, and vary about 20 per cent. Several other useful values worked out mathematically.

Plans are under way for further experiments on submerged models to determine the stream line flow about the models, as a means of arriving at improvements in form, as well as to calculate the effects of cockpit openings, sponsons, etc., and to study the torque at different angles.

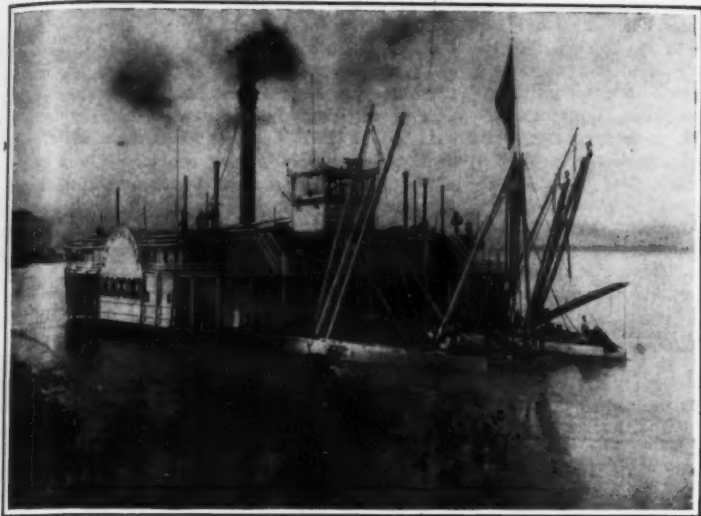
Wheatstone Bridge for Resistance Thermometry

THERE has just been issued by the Bureau of Standards of the Department of Commerce a paper describing a Wheatstone bridge designed with especial reference to flexibility of use in measurements with resistance thermometers and discussing the use thereof. The bridge is adapted to use with either the Siemens type or Callendar type of resistance thermometer or with the potential terminal type of thermometer by the use of the Thomson double bridge method. The instrument is also arranged so that it may be completely self-calibrated.

The accuracy attainable with the bridge is such that resistances of one ohm or more can be measured to an accuracy of one part in 300,000 in terms of the unit in which the calibration is expressed. This corresponds to an accuracy of about 0.001 degree for measurements with the platinum resistance thermometer. Low resistances, the accuracy of measurement of which is limited by variations in contact resistances, may be measured to about three millionths of an ohm. This figure, rather than the one given above for accuracy, represents the precision attainable in measuring small changes of resistance, such as are usual in resistance thermometry.



Side views of five models.



The snag boat "John Macomb" at work on the Mississippi River, showing double bow and numerous lifting derricks.



Front decks of snagboat, showing openings in bow permitting snags to be lifted to a position where they can be sawed into sections.

Snag Boats on Flood Rivers

A Safeguard to Navigation

By Day Allen Willey

MANY of the so-called flood rivers in the South and West, flow through channels where the bottom and sides are merely of earth and sand, and when a river is in flood the current washes out the banks, causing woodland, prairie soil, and other formation to be submerged, and, in some instances the surface of the land, to the depth of several feet is carried down stream by the current in the form of liquid mud.

Such rivers as the Mississippi, the Arkansas and the Red River run through swamp lands in some locations which are covered with trees and bushes. In high water trees are often uprooted and float down with the current. When the flood recedes, the trees may be held in the stream channel, the roots sinking into the bottom and remaining in such a position that they form dangerous obstacles to navigation. Often the upper end is but a few feet below the surface, and a vessel moving in line with it may be pierced through its hull and sunk as the pilot is unaware of the "snag."

Where these washed-out trees project above the water, they are almost as dangerous as the sunken snags, as they are often in eddies and cross currents in the channel where a steamboat may be wrecked against them.

The War Department has adopted several methods to free these navigable rivers of snags. An idea which has recently been adopted is to bore holes in the wood, insert dynamite cartridges, and thus shatter them to pieces. The most effective plan, however, is to pull them out of the water and saw them up, sometimes

using the pieces for fuel for heating the furnaces of the boats which pull them out by steam.

These snag boats were the idea of one of the army engineers, and the first was built about 10 years ago for service on the Mississippi river. Since then the boats have been enlarged, equipped with more powerful lifting derricks, operated by a steam engine which is independent of the one which propels the boat.

One of the latest types of these floating snag pullers is stationed on the Mississippi river. It draws less than 4 feet of water, and consequently can be operated on shoals and in other shallow spots. Two engines of a combined capacity of 600 horse-power furnish motive power, giving a speed ranging between 5 miles and 6 miles an hour upstream against a strong current.

The double bows are separated by what is termed a well which is 12 feet in width, each bow being 65 feet in length. At the forward end what is termed a "butting beam" extends from bow to bow. This is a heavy steel beam 22 feet in length, 7 feet wide, and no less than 16 inches thick, greatly strengthening the framework of the boat. As the name implies it is used to ram or butt a snag when necessary to dislodge it from the bottom before pulling it out of the water.

Attached to this beam is a sweep chain which drags beneath the water and is designed to grip the lower portion of the snag and aid in lifting it to the surface. This chain is lowered over the bows by a capstan placed at one end, and raised in the same manner. Its purpose

is principally to lift the upper end of the snag high enough to permit the butting beam being pushed under it.

Upon the bows are the lifting derricks, one being utilized to pull out small snags after they have been loosened by the sweep chain and butting beam. Those on the sides are intended to pull up obstructions which can be readily removed by means of block and tackle.

On the boat the crew includes a diver whose duty it is to go under water when necessary to fasten the chain around the trunk, or to bore holes in the wood for the dynamite cartridge and connect its detonator with the wire that extends to the electric keyboard on the boat.

Another large snag boat is in use on the Mississippi and tributary waters which is 187 feet in length, 52 feet beam over the hull, and can operate in water $3\frac{1}{2}$ feet in depth. It is also constructed with a hull of steel and iron, and driven by two oscillating engines, steam being furnished by five 42-inch boilers giving it a total horsepower of about 500. The snagging apparatus consists of two pairs of friction capstans placed in the forward hold and six capstans installed on the deck.

The "Suter" carries a butting beam of oak plated with iron, also a series of five iron shear legs in addition to supporting blocks and tackle, a Sampson chain of $2\frac{1}{2}$ -inch links, and a sweep chain.

Such is the capacity of these snag pullers for removing the obstructions to navigation that by the service of this fleet one of the greatest dangers to steamers and barges plying on the flood rivers, has been largely abolished.

Diseases Dangerous at Different Periods of Life

MUCH has been said of late concerning preventable diseases and methods of reducing the annual rate of mortality. The first essential of any such schemes is a carefully prepared summary of the causes of death in a particular country during a specified period, and a statement of the age and sex of those dying within this term of years. For some twenty years the German Empire has published statistical tables of all officially reported causes of death. These have always been divided into periods of life and of late years have distinguished sex. They do not, however, cover the entire population, for the participation of the different states of the empire is voluntary; but there has been a gradual increase until four years ago 98.85 per cent of the inhabitants of the empire were included in these digests. An interesting analysis of the main causes of death at different periods of life, as shown by these tables, is made by Dr. C. Rahts in a recent number of the German journal *Umschau*.

Speaking of infants under one year of age he states that in the decade 1892-1902 the deaths among such infants averaged, during a calendar year, about 20 to 25 of each 100 born alive, and in the five years 1906-1910 only 17 to 18 of each 100. Of late years about 342,000 children die annually in Germany, 332,000 of them dying of known causes. For more than one third of those dying of known causes within the first year the indicated ailment is chronic gastro-enteritis or cholera infantum, that is, the illness arose from unobtainable or defective nourishment. For about one seventh congenital weakness is the stated cause of

death, which occurred generally in the first month of life. Other fatal maladies noticeable for their frequency among infants less than a year old were inflammation of the lungs, to which 115 of each 1,000 dying succumbed, and whooping-cough from which about 30 of each 1,000 deaths arose. Tuberculosis, measles, and scarlet fever, taken together, carried off less than 3 in each 100 deaths of young infants, that is, less than whooping-cough alone.

For the period of childhood from the beginning of the second year to the end of the fifteenth year Dr. Rahts finds, in his examination of the tables, that the annual average of deaths was about 111 to 112 per 1,000 living; the annual average during the five years 1906-1910, from which the figures are mainly drawn, was about 140,000 children, of whom 3,300 died of unknown causes. The most important causes of death given for this age per 1,000 children who died are: Pneumonia, 147; other diseases of the respiratory system, 65; tuberculosis, 105; diphtheria (including croup), 92; scarlet fever, 64; measles, 54; whooping, cough, 39; diseases of the digestive tract (including appendicitis and its consequences), 110; accidents, 45.

In discussing the statistics just given, Dr. Rahts says: "According to this in the period from 1 to 15 years life is threatened to a large degree by four widely spread, easily conveyed diseases of childhood, diphtheria, measles, scarlet fever, and whooping-cough, for these four diseases together cause the death of almost the fourth part, 22 per cent exactly, of all who succumb in this period of life. After these, pneumonia, or some other disease of the respiratory system, is designated

as the cause of death for fully one fifth, 21.2 per cent of all who die from known causes, and tuberculosis as the cause for fully one tenth. Disease of the digestive tract, including appendicitis, was a somewhat more frequent cause of death than tuberculosis. Lastly, the large number of fatal accidents at this age is noticeable, for about 1 of every 22 cases was attributed to 'death by accident.'"

According to these tables, tuberculosis of the lungs carried off the greater number of those who died in the period between 15 and 30 years of age. During the years 1906-1910 the deaths from this disease were 462 per 1,000 deaths from known causes among women and 375 per 1,000 deaths among men. Other forms of tuberculosis in addition are given as the cause of death for a further 35 per 1,000 deaths. Among those from 15 to 30 years old other forms of disease, as compared with tuberculosis, are much less frequently the cause of death. Among every 1,000 males (females) who died from known causes at this period of life there were: 65 (77) deaths from diseases of the heart or of the blood-vessels; 61 (46) from pneumonia; 33 (37) from other diseases of the respiratory system; 51 (54) from diseases of the digestive tract, including appendicitis.

In continuing his analysis Dr. Rahts says further: "Besides the diseases mentioned, a very frequent cause of death in this period of life is an injury, especially among males. Of each 1,000 cases of death among males no less than 128 resulted from accidents and 67 from suicide, that is, almost 1 in 5 arose from some form of violence. Among females from 15 to 30 years

of age accidents which resulted fatally and suicide were much less frequent, only about 1 death in 22 or 23 being caused among females by such violence. In place of this, however, puerperal fever is frequently mentioned as the cause of death during the youthful age of 15 to 30 years, namely for 30 of each 1,000 females dying."

Tuberculosis of the lungs is also, according to these tables, the most fatal disease in the period of greatest vigor, the age from 30 to 60. Of each 1,000 males who died 222 succumbed to this malady, and 207 of each 1,000 females dying. The next most frequent causes of death in this period were diseases of the heart and of the blood vessels; 156 of each 1,000 females and 135 of each 1,000 males who died succumbed to such maladies. As in the previous period of life, heart troubles seemed to be more often fatal to women than men. In this age of 30 to 60 cerebral affections and spinal diseases become very noticeable as causes of death, for about one tenth of all the men died from cerebral apoplexy or of some diseases of the nervous system, the proportion of women dying from these diseases being not quite so large. In this period of life also cancer and other malignant tumors were a frequent cause of death. Such new growths are more frequent among women than men, being noted as the cause of death for about 3 of every 20 females dying

and for about 3 of every 33 males. The large number of suicides and fatal accidents in the age from 30 to 60 is likewise very striking, for of all the causes of death among males about one twentieth, 4.9 per cent, resulted from suicide, and nearly one eighteenth, 6.3 per cent, from accidents. The percentage for such causes among women is somewhat smaller.

The official statistics show that after the close of the sixtieth year of life a frequent cause of death is old age. It is given for more than one third, 36.4 per cent of all women who died and for more than three tenths, 30.4 per cent of all men. There was apparently no disease or injury in these cases, but a wearing out of the organs of the body.

"If we leave aside," continues Dr. Rahts, "those who died apparently of old age, that is, take into consideration after the close of the sixtieth year only those who died from a more definitely designated disease or injury, we find that nearly one fourth of these died from some disease of the circulatory system, that is, from a disease of the arteries or heart, and probably the cause of death reported for the persons entered in this column of the tables has been largely a hardening of the arteries (arteriosclerosis). Further, fully the eighth of those not dying from old age succumbed to cancer or to the consequences of some other new growth, namely, 13.55 per cent of all such females and

12.13 per cent of all such males. Outside these diseases life at this advanced age is mainly threatened by cerebral apoplexy, pneumonia, or other disease of the respiratory system, as asthma or bronchial catarrh. In this period tuberculosis is apparently by far not so common a cause of death as pneumonia. Suicide, accident, or influenza are about equal as causes of death, namely for about 1 in every 50 males who died excluding those who died of old age. On the other hand, among elderly females suicide or fatal cases of accident causing death were noticeably less frequent than influenza."

There seems to be some danger for women in Germany of dying in childbirth. During the decade 1892-1910 for every 10,000 living or stillborn children 30 women died in childbirth, of whom about 16 died of puerperal fever, and about 20 of other results of confinement. Several diseases which are greatly dreaded elsewhere and which are easily conveyed, as small-pox, typhus, and leprosy caused but few deaths in the empire during the decade 1892-1902, as did also certain animal diseases to which human beings are susceptible, namely, hydrophobia, glanders, anthrax, and trichinosis. All these diseases just mentioned taken together caused the death in Germany annually of 2.3 persons in every million inhabitants, so that the danger from them in this country is very slight.

Artificial Production of Vigorous Trees*

Valuable Sports and Hybrids That Have An Interesting History

In an article on the artificial production of vigorous trees, contributed to the Journal of the Department of Agriculture and Technical Instruction in Ireland (No. 1, October, 1914) Prof. Augustine Henry discusses the nature of species, varieties, races, sports, and hybrids, as they appear to be from his researches. Natural species, in the case of trees, are readily recognized by the occurrence of each in a definite region or habitat. We have thus one species of silver fir in Central Europe, another in Algeria, a third in Southern Spain, etc. Of our common trees—oak, birch, and elm—there are pairs of species in the same region, each, however, occupying a different habitat, one species adapted to a dry situation, the other suited to a moister soil. The pedunculate oak is a native of valleys and alluvial flats. It is not protected against evaporation of water, the supply of which in the ground it prefers being always ample. The sessile oak is a native of hilly and rocky districts, where water is not abundant in the soil. Its leaves are covered beneath with hairs, which guard against excessive loss of water by transpiration in windy weather. Similarly two alders exist on the Continent, but only one species, *Alnus glutinosa*, reached our islands, after the retreat of the ice sheet, and before the land connection with France was severed by the formation of the Straits of Dover. The other species, *A. incana*, grey alder, is absent from our native flora, but when introduced is very hardy, and is useful for planting in low-lying situations liable to spring frosts. The ash requires such special conditions of soil, that only one species exists in Northern and Central Europe, there being no suitable soil for a second species to inhabit.

A natural species is often a set of individuals uniform over a large area; but it may consist of two or more "geographical varieties," which correspond with distinct territories, each marked by slight differences of foliage, etc., that render the variety better fitted for its own habitat. Thus the Corsican and Austrian pines are closely related, but the latter keeps its leaves two years longer on the branches, so that the dense shade of its abundant foliage preserves moisture in the crevices of the hot limestone rocks, on which it grows in its Austrian and Servian home. The Corsican pine, with half the foliage of the other tree, thrives on granite soil in the moist insular climate of the mountains of Corsica. These two pines—only notably distinct in one character, the amount of their foliage—are usually regarded as two geographical varieties of the same species, *Pinus Laricio*, but by some botanists are considered to be two distinct species.

In a species apparently uniform over a large area there may exist varieties, characterized by minute and scarcely describable differences. This is exemplified by the Scots pine. Plots of its seedlings, raised from seed of trees in the forests of Scotland, Russia, Switzerland, etc., differ in vigor and in other respects (immunity to certain fungi, etc.), when all are grown together under identical conditions. Such varieties, with slight differences of structure, may be called races, and are of great practical importance in forestry. Only seeds of the

best race, that is, from vigorous trees of the most suitable locality, should be used.

A sport is usually a solitary phenomenon, arising either as a sporadic peculiar seedling from a seed, or developing out of a bud on a tree as a single branch with some peculiarity of twig or leaf. A sport may be looked upon as a freak, not forming the starting point of a new species, but speedily becoming extinct if left to nature. Sports, when of interest on account of the curiosity or the beauty of their appearance, are propagated usually by grafts, cuttings, or layers; being only in rare cases perpetuated by seed. Some sports are due to arrested development. The tree, in the course of its life, often passes through stages, like those of an insect. The seedling of many species differs from the adult tree as a larva from a butterfly. The infant ash has simple leaves. The sport known as the simple-leaf ash is simply a seedling ash, which has never progressed to maturity and may be called a persistent larval form.

Abnormal coloring of leaves, so-called variegation, is a sport, usually starting as a solitary branch on an otherwise normal tree, which, when noticed, is propagated by grafting. Deeply-lobed, crumpled, pitcher-like, and other abnormal leaves occur in many species, and are propagated as curiosities. In sports, reversion is often seen; thus on a fern-leaf beech one or two branches with normal leaves are not uncommon. This reversion may be due to the influence of the stock, as these sports are usually grafted; or it may be explained as the triumph locally of normal over abnormal factors. Such reversions are never seen in hybrid trees. The occurrence of a sport seems to predispose to further sporting; a tree with leaves abnormal in shape will sometimes take on, in one branch, abnormal color as well. These double sports are common in the holly.

Hybrids are combinations of two species or of two varieties, which arise either in the wild state or in cultivation. They are met with in nature as rare individuals on the boundary line between the area occupied by two species. This is well seen in Yorkshire, where a hybrid oak is found in the localities in which the sessile oak of the hills comes in contact with the pedunculate oak of the valleys. Hybrids arise frequently in nurseries, gardens, and parks, where several species are cultivated together.

Hybrid trees are more common than has been supposed. Many valuable trees, the real history of which has not been suspected by botanists, are of hybrid origin. As an example, may be mentioned the fine elm, which is universally planted in Holland and Belgium, where it is known as *orme gras* or *Ulmus latifolia*, Poederlé. This is not, as sometimes imagined, a natural species peculiar to those countries. It is unquestionably a hybrid, which is invariably propagated by layers, all the individual trees on this account being uniform in appearance. It seems to have originated three or four centuries ago, probably as a single seedling, which has given rise by vegetative reproduction since to millions of descendants.

The distinction between sports and hybrids is well known in the numerous so-called "varieties" of the

holly. Some are sports of *Ilex Aquifolium*, our native holly; others are hybrids, one parent being the common holly, while the other is either *Ilex Perado*, which was introduced from Madeira in 1760, or *Ilex Balcanica*, the holly of the Balearic Isles, which was cultivated at Versailles in 1789. Miller, in his account of the hollies in 1750, was acquainted only with the sports, which had arisen from the common holly, as the other species had not been introduced at that time and hybridization was impossible. The hybrids originated soon after 1800, the earliest apparently being *Ilex Hugoini* and *Ilex Hendersoni*, which were found by Holms as seedlings in his nursery at Dunganstown, Wicklow. Here *Ilex Perado* was cultivated; and old specimens producing flowers and fruit freely are still common in Wicklow gardens. The holly hybrids are vigorous trees, bearing large leaves intermediate between the parent species. The sports of the common holly are always grafted, and are feeble in growth, with a tendency for single branches to revert occasionally to the normal form.

With regard to hybrids, Prof. Henry, by historical research and experiment, has established the fact that many fast-growing trees in cultivation as the Lucombe oak, common lime, cricket bat willow, black Italian poplar, etc., are hybrids. By artificial pollination he has succeeded in raising new hybrids, which display the extraordinary vigor characteristic of the first generation cross; and in his paper gives an account of these. The most notable so far are a hybrid poplar (*Populus generosa*) and crosses between the common ash and American species of *Fraxinus*.

Advantages of Surface Combustion

AN English firm introduced the Bove system of surface combustion with liquid or solid fuels for which decided advantages are claimed. Among the special applications illustrated by the booklet are those to enameling, forging, annealing, bolt-making, glass-working, and metal-melting. It is stated that until recently it has been necessary in the enameling industries to employ muffle furnaces in the heating of the ware, for if the combustion gases gain access to it the lead oxide in the enamel is reduced and the work ruined. This effect is due to the incomplete combustion of the gases. As the result of a special test carried out by representatives of an important manufacturing firm, it appears that the combustion products of the new system do not impair the enameled surface, and, therefore, may be allowed to have free access to it, so dispensing with the necessity of muffles, and effecting a great saving in fuel. The advantages claimed for the system generally are: (1) The combustion is greatly accelerated by the incandescent surface, and, if so desired, may be concentrated just where the heat is required; (2) the combustion is perfect with a minimum excess of air; (3) the attainment of very high temperatures is possible without the aid of elaborate "regenerative" devices; (4) owing to the large amount of radiant heat developed, transmission of heat from the seat of combustion to the object to be heated is very rapid.

* From Nature.

Electro-Culture of the Soil

A Discussion of the Part Taken by Electrical Processes in Biological Reaction

DURING the past few years there has been much speculation as to the effects of electricity upon the development of plants and various experiments have been made in the stimulation of germination or growth by electricity, either by the use of electric lights or by the transmission of currents of electricity to the plants or the earth. Results have varied, some investigators claiming great successes, while others express doubts as to the practical value of such methods, or even assert that crops of different kinds are injured by the use of electricity.

One of the advocates of the benefits of electricity for vegetation is Prof. Dr. W. Löb of Berlin, who read an interesting paper on the question at the session in Leipzig in May, 1914, of the German Bunsen Association for Applied Chemistry. Acknowledging that the problem was still unsolved, but claiming that the effort in any direction to settle it was of value, he reminded his hearers that under natural conditions vegetable life exists in the conductive surface of the earth and has above it the dielectric atmosphere. As electrical processes resulting from these conditions, there may be an electrolysis within the earth which produces a directed transmission of ions and a discharge of ions at the electrodes, or by cataphoresis the relations of the colloid substances of the earth or of the parts of the plants are shifted. There can, further, be a fall of potential in the layer of air surrounding the plants, followed by the seeking of equalization through the dielectric atmosphere with the ground or the surfaces of the plants. This latter form of influence is the one best suited for imitation in practical electro-culture, in which there is generally an insulated metal frame or an insulated metal lattice-work stretched parallel to the ground at a certain height above it and equipped with high voltage electricity, which is equalized with the ground by constant discharge.

The natural form of electrical energy to which this practical method bears the closest resemblance, that of silent discharge, opens up the question of the reactions attainable through the equalization of differences of potential by means of a dielectric, a question which extends far beyond the problem of electro-culture. For, as it is certain that the differences of potential necessary for the discharge exist in nature without the aid of artificial devices, they must co-operate in proportion to their chemical activity in the natural reactions. In regard to atmospheric electricity, Berthelot proved that differences of potential, which vary from 7 volts per meter in dry weather to 500 volts in damp weather, appear between layers of air, between air-surfaces and leaf-surfaces, or between the air and the ground. The equalization of these differences generally occurs in the form of dark discharges. Another form of continuous discharge at the earth's surface is the glow discharge. The part taken by sunbeams in generating the surfaces of potential-levels has been investigated of late years by Nodon, and in the sunbeam, we should remember, besides the heat and light rays, ultra-violet rays are also active, the importance of which for ionizing in gases, or in the generation of electrons, is known.

All this led Dr. Löb, who had spent many years in investigating the chemical effects of the silent discharge to take up the problem of electro-culture in connection with the silent discharge and to make experiments to determine the part taken by the electrical processes in the chief biological reactions. In his address, which is given in the German journal *Zeitschrift für Elektrochemie*, he says:

"In order, first of all, to gain a general position to this problem, it is only necessary to recall that undoubtedly during the process of equalization of the differences of potential in the dielectric, if the dielectric is moist air, definite reactions are regularly caused, as, for instance, the formation of ozone, peroxide of hydrogen, and oxide of nitrogen. The further question naturally arises, whether these substances influence the vegetative processes, as the assimilation of carbonic acid and nitrogen, or processes of oxidation, whether they accelerate or retard the numerous enzyme reactions. It is also known that chemical reactions are not merely limited to the domain of gases, but that the interface between the ground and the air also causes reactions which directly affect the substances within the ground. Thus, Berthelot proved that a number of fixed bodies and fluid substances absorb nitrogen. If the ultra-violet rays are also taken into consideration, the number of possible reactions is much larger. Recently Neuburg, among others, showed how easily and completely many biologically important substances are changed by the ultra-violet ray."

These conditions and results lead to the deduction that electrical energy is of much importance in the reactions of life. The silent discharge seems to be especially suited for use in investigating such reactions because in it, under exclusion of higher temperatures, electrical energy appears united with the ultra-violet ray, as has been shown by Warburg, and because relatively strong chemical effects are produced.

Among the biologically important investigations undertaken by Dr. Löb are: "1. The assimilation of carbonic acid from moist carbonic acid over formaldehyde up to glycolaldehyde; 2. the synthesis of the fatty acids connected with the assimilation of carbonic acid; 3. the synthesis of glycocol from carbonic acid, water, and ammonia over the intermediate stage of the formamides, a reaction which may be regarded as the first phase of the assimilation of nitrogen in the process of the formation of albumen; 4. the hydrolysis of starch; 5. the removal of the amino group from glycocol."

When these results are compared with the reactions which can be produced in the atmosphere, as the formation of ozone, peroxide of hydrogen, and oxide of nitrogen, the reactions attainable by the action of the silent discharge may, according to Dr. Löb, be summed up as follows: "a. Direct syntheses or decompositions are produced from the substances of the atmosphere or of the conducting electrode (fluid or surface of the earth); b. substances are produced which either retard or accelerate other biological processes; c. reactions, the course of which only affect themselves, are accelerated or retarded directly by the influence of the electrical discharge, that is, without catalytic agents."

In company with Dr. A. Sato, Dr. Löb, about a year ago, took up the question whether the enzyme reactions, so important for the germinating plant, are modified in their course by the influence of the electrical discharge. To settle this point it was necessary to determine: the condition of the substrata under the influence of the discharge, whether the enzymes are affected by the discharge, and in what way the discharge acts upon the enzymatic modification of the substratum. The experiments had to be made both with atmospheric air, and under its exclusion in order to avoid the appearance of ozone, hydrogen peroxide and oxide of nitrogen, and involved tedious and delicate experiments.

As the experiments sought only to determine the main conditions, animal not vegetable enzymes, were used, solutions of suitable dilution being made from the dried substance of the pancreas of hogs. The results showed that the enzymes and substrata used were matters of importance, so that there is a possibility that the action of the discharge upon the vegetable enzymes might be different from its action upon the animal enzymes. Among the most important enzymatic processes of the germinating plant are the diastatic, tryptic, and lipolytic reactions of the enzymes. In his summary of results Dr. Löb says:

"1. Watery solutions of starch are hydrolyzed under the influence of the silent discharge and the glow discharge in the presence of oxygen and under its exclusion. At the same time the part of the starch not hydrolyzed is altered in another way, perhaps in the direction of a polymerization, so that the part of the starch exposed to the discharge but not hydrolyzed has more power of resistance to diastase than starch not treated by electricity. 2. The diastatic properties of the pancreatic solutions are decidedly retarded by the electrical treatment. 3. The reaction between diastase and starch is retarded by the electrical treatment. 4. Peptonized silk (partially hydrolyzed silk) solutions are hydrolyzed only slightly by the discharge, whereby a little free ammonia appears. The amount of the amino acids and of the non-colloidal nitrogenous substances are not demonstrably increased. 5. The tryptic properties are retarded by the discharge. 6. In the presence of peptonized silk the tryptic properties are not demonstrably injured through the peptone. 7. In the presence of fibrine the electrical treatment increases the tryptic properties which act upon this, the digestion of fibrine is accelerated."

It was, curiously, found that in some cases the discharge injured the enzyme when the latter was exposed to it without a substratum, while when the substratum was present the action of the enzyme was accelerated. The reason for this may be that the discharge changes the colloid condition of the enzyme and encourages flocculence. If this process begins without a substratum it is possible that the adhesion of the enzyme to the substratum is made more difficult should the latter be added later. If the substratum is present during the development of flocculence, the chemical affinities undoubtedly

exist between it and its enzyme may influence the adsorption process between the two in the same direction, thus accelerating the enzyme reaction.

Another fact gained from the experiments is that the nature of the substratum is of importance for the effect of the discharge, which would imply that the sensitivity of the specific character of the enzymes varies as regards electrical treatment. The reactions of vegetative life, assimilation of carbonic acid and nitrogen, process of oxidation and reduction, enzymatic decompositions of highly molecular substances, which frequently precede further transformations, as well as the numerous processes of polymerization and syntheses of other kinds, are all closely connected with the form of the supply of energy. Numerous questions arise as to the action of the sun's rays on the growth of plants and the connection of light and heat with electrical energy. These questions will have to be experimentally answered before the scientific basis of electro-culture can be laid.

In the discussion which followed the reading of the paper before the association at Leipzig some doubt was uttered as to the actual results of electro-culture, the opinion being expressed that the effects of electricity seem either negative or secondary. The necessity was also dwelt on for extreme caution in all such experiments, as ferment infections caused by ordinary micro-organisms could lead to mistaken deductions. F. Haber of the Kaiser Wilhelm Institute, at Berlin, gave the results of his investigation with others of the assimilation of a leaf of cherry laurel in air filled with carbonic acid. It was found that the electric field produced no change in the assimilation unless a glow discharge was obtained. Both continuous and alternating currents were used, also an alternating field was tried. The reaction produced by the glow discharge injured assimilation. The admixture of ozone or oxide of nitrogen with the air had the same effect as the glow discharge. The concentration was diluted until no injurious effects were perceptible, but no useful results were attained. In conjunction with these experiments, Messrs. Knight and Priestley of the Botanical Garden of the University of Leeds investigated the breathing of plants under the influence of electric fields and reached only negative results. These and the investigations of other scientists mentioned led him to the opinion that when success is obtained in electro-culture the question proves to be not that of electrical action upon one of the physiological functions of the plants, but merely that of an entirely secondary effect of electricity.

In reply to the inquiry how he supposed the glow discharge affected enzyme action, whether it was through the production of certain chemical substances which influenced this action, Dr. Löb said that any influence could only be on the surface, as the enzyme solution forms an electrode within which hardly any perceptible fall of potential could take place. The entire fall of potential occurs in the atmosphere; the reaction takes place on the surface of the fluid. Perhaps the best way to describe how the chemical action arises would be to compare the phenomena with the action of the ultra-violet ray. If ultra-violet rays are thrown on a sterilized solution of sugar the solution at once changes, it absorbs oxygen, oxidizing processes appear, etc. With the aid of the theory of electrons, various schemes could be advanced as to how this happens, but he did not wish to form a definite theory until more facts had been determined. C. Schall of Leipzig spoke of an experiment once made with an electrically charged metal in a solution with which it acted when not charged. It was claimed that the resulting yield was greater, so that perhaps the reaction was accelerated in some manner. It was also supposable that leaves charged at a fairly high potential, 100 volts, could, when the constituents there combined, act upon the speed with which a reaction takes place on the surface.

In reply to an inquiry as to how the experiments were made, Dr. Löb said the enzyme solutions were exposed to the discharge in suitable vessels, and simultaneously the same solution was set in a similar vessel without exposure to discharge. Then the enzyme strength of these enzyme solutions was determined, and it was settled whether the speed of the enzyme reaction had been increased or retarded in the hydrolysis of starch or in the digestion of peptone, casein, or fibrine. Next the behavior of the substratum without the enzyme under the influence of the discharge was investigated, and after all this the enzyme reaction on the substratum was allowed to go on to completion simultaneously under the effect of a discharge and without discharge. The result was quantitatively determined.

Fig. 3.—A physiological record of radio time signals. Irregularity in record is

Fig. 4.—A record showing extreme fatigue of the muscle

Records of Radio Time Signals*

Made With a Physiological Recorder

By Prof. C. W. Waggoner, West Virginia University

From the date of Galvani's historic experiment with the frog muscle in 1786 to the present, physiologists have investigated the effect of electrical and mechanical stimulus upon this remarkably sensitive physiological mechanism. Helmholtz is credited with having made the first careful study of the muscle-nerve preparations in 1852 and the use of these preparations from the frog for the study of the characteristics of these tissues is common in all physiological laboratories.

This paper is a report on some records made with the muscle-nerve preparations of a frog of the radio time signals sent from the Government naval station at Arlington, Va., and received on a small aerial erected on the campus of the West Virginia University.

Dr. Lefevre¹ of the University of Rennes, France,



Fig. 1.—Receiving apparatus.

succeeded in obtaining some records of the wireless signals sent from the Eiffel Tower, Paris, by using the muscle-nerve preparation of a frog, transmission of such signals from Paris to Rennes being for the most part over very level land, and at a distance of approximately two hundred miles. He used a sensitive electrolytic receiver, shunting the recorder current around the high resistance telephones which were placed in series with the detector and potentiometer.

The distance from Morgantown to Arlington, Va., is approximately 162 miles and in between lie three big mountain ranges, one ridge of which rises 2,200 feet above the level of the campus. The aerial used in these experiments consisted of four cables of stranded copper wire, seven strands of No. 21 wire to each cable. The aerial is of the inverted L type, the highest point being 112 feet above the ground, and has sufficient length to give it a natural wave-length of 375 meters.

In Fig. 1, showing the receiving apparatus, *A* is an induction type receiving transformer which was constructed in our shop, and has a tuning range of 50 to 4,000 meters with a comparatively short aerial. *C* is a variable condenser of approximately 0.001 microfarad capacity. *W* is a buzzer-driven wave-meter, the inductance of which is loosely coupled with one turn of the aerial lead-in. The electrical connections are those commonly used for receiving long wave-lengths. The secondary of the receiving transformer is shunted by the variable condenser to insure ease in sharp tuning;

* A paper read before the American Physical Society, Washington, D. C.

¹ *Lond. El.*, vol. lxxi, 1913.

around the secondary is also shunted a circuit containing the detector and a small fixed condenser in series. The terminals leading to the recorder are connected to a switch so that either the recorder leads or the telephones may be shunted across the small fixed condenser. The buzzer used to excite the wave-meter is of the type described by Austin.² The buzzer is very simple to construct and gives such a steady, high pitched note in the telephones that we have found it a very valuable addition to the general equipment of the laboratory. The buzzer shown in the figure will operate on two dry cells for six to eight hours at a time without requiring any adjustments or attention. Such a buzzer is essential to the most careful adjustments on the silicon detectors. The detectors are shown in the figure at *D* and are mounted upon a spring support. Simple silicon-steel detectors without batteries were used throughout these experiments, and it was found that they were amply sensitive for the recorder. The spring support for the detectors was found to be a great convenience. Those who have used this type of detector know how sensitive it is to a slight jar, and with this type of support there was no difficulty keeping several detectors in adjustment for weeks at a time without disturbing them in the least. The experiments were made during February and March of last year, and little trouble was experienced from static discharges in the atmosphere.

The mechanism for making the records is shown in Fig. 2. The frog is shown at *F* (the table upon which it was mounted was tilted to the vertical position for the photograph). The preparation was made by removing the frog's brain, destroying the spinal column and dissecting out the sciatic nerve which energizes the gastrocnemius muscle. The muscle was cut free at the lowest point and fastened by a cord to one end of the long lever shown at *L*. This lever, with a suitable sharp marker on its end, was arranged to move, at the contractions of the muscle, over a smoked paper kymograph *K* driven by a constant speed motor *M*. At *T* is shown a small Zimmermann time-marker which was adjusted to record seconds simultaneously with the record made by the muscle-nerve preparation. This time-marker has a fine Swiss watch movement, and a comparison of its record with the standard time record made by the muscle will show an error too small to be determined on the scale drawn on the record.

The method of making a record was to tune the receiving transformer with the aid of the wave-meter to 2,500 meters; then as soon as the signals began to arrive the telephone leads were replaced by the leads to the recorder, and the two platinum points or electrodes in contact with the nerve were moved along the nerve until a strong but regular response to the signals was obtained. The records were fixed by coating them with a thin solution of shellac in alcohol.

With a satisfactory preparation no difficulty was met with in getting full five-minute records of the time signals both at 12 noon and 10 P. M. (eastern time), often the same preparation serving to make records at both these hours. In a number of cases it was found that when a frog was prepared only a few minutes before making the record it was entirely too sensitive, and a complete tetanus would result from the stimulus of the first few signals, and no results could be obtained. After twelve or fourteen hours this same preparation

² Austin, *Bull. Bur. of Standards*, vol. vi, 1910.

would often give an excellent record. A few frogs were found whose muscle-nerve preparations failed to respond at all. This failure may be due to the fact that only winter frogs were to be had and at this time in their hibernation their vitality was probably very low.

Figs. 3 and 4 show some records made by this type of recorder. Fig. 3 shows a record made by a freshly prepared specimen. This record was taken at 10 P. M. and on the record following the time dash at 10 will be found the weather signals. The muscle-nerve preparations will not respond to rapidly repeated stimuli, especially if the muscle is fatigued, as was the case in the record shown in Fig. 3, and it is of course impossible to interpret the weather signals from this record. It

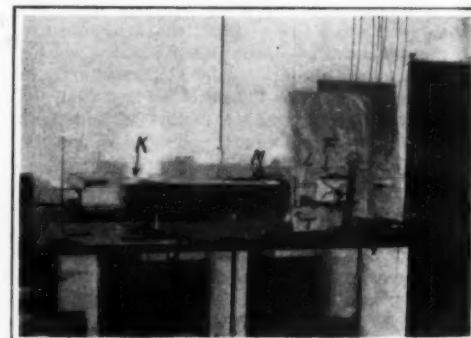


Fig. 2.—Recording apparatus.

was possible often to record the operator's signature at the close of the last time dash, but only when the frog was used in making signals for two or three minutes. Fig. 4 is a record showing extreme fatigue of the muscle. This record was made by a muscle-nerve preparation which had been prepared twenty-five hours before this record was made and the rapidly decreasing amplitude of the vibration indicates the fatigue.

From the experiments performed it seems that this type of recorder, while remarkably sensitive to small electrical impulses, is limited to slowly applied signals if the record is to be taken for any considerable length of time. A freshly prepared specimen will show complete tetanus if the impulses occur as rapid as twenty-five or thirty times a second. We were unable to get any very satisfactory records of the weather signals, except to record some of the numerals which consist of well spaced dots and long dashes, even with a freshly prepared specimen.

Like all recorders, this one responds to static discharges, and if the static current is very strong the high current tends to cause tetanus and ruin the record. It is possible that this type of recorder could be used by observatories in connection with the chronograph for finding the rate of clocks, making use of some sort of an amplifier, such as the Audion, in such stations so far distant from the sending station that the received current on the antenna would not be sufficient to operate the muscle-nerve preparation. The response to the signals is very rapid. Physiologists have found that this muscle-nerve preparation will respond to the stimulus in one-one hundredths of a second after the current has reached the nerve.

in the speed of the kymograph. Decrease in amplitude shows muscular fatigue.

operation had been made twenty-five hours before using.

Hydrogen, Its Technical Production and Uses*

By A. F. Seeker

In recent years the cheap production of hydrogen on a large scale for technical purposes has become a problem of some importance. Formerly it was used occasionally for filling balloons and in the oxy-hydrogen flames of the so-called "calcium light." Being the lightest of the common gases and of a correspondingly high sustaining power, it has become essential for the filling of dirigible balloons with their heavy burden of propelling machinery. Such uses, however, have become of rather secondary importance, and it will probably be only a short time before the dirigible balloon and the "calcium light" will have been permanently discarded in favor of heavier than air machines and varied forms of projected lights operated by electricity.

The oxy-hydrogen flame is now becoming a common tool in the hands of the artisan in working refractory metals; liquid oils and soft greases are now "hydrogenated" to produce acceptable lard and butter substitutes, and also solid fat suitable for the manufacture of hard soaps; and lastly, the use which promises to consume enormous quantities, ammonia is manufactured from hydrogen and atmospheric nitrogen. All these uses tend to make the problem of the production of cheap hydrogen one of considerable importance.

The employment of the oxy-hydrogen torch is too well known to require description here. The commercial "hydrogenation" of oils and fats is of recent introduction. The process consists in treating the oil or grease in a suitable vessel containing a catalyzing agent, generally nickel, with hydrogen under pressure. The oil is violently agitated in order to bring it into intimate contact with the hydrogen and catalyzer. The result is that the glycerol esters of the unsaturated fatty acids, which generally consist for the most part of oleic acid, become saturated, and the mono-, di-, or triolein, as the case may be, is converted into the corresponding stearin. The oleins are either liquid or semi-solid at ordinary temperature, and produce soft soap or soap that will not hold much water without becoming soft. The stearins are solid fats at ordinary temperatures and produce hard soaps. Thus by the process of hydrogenation, cotton seed and corn oils are to-day being converted into lard and butter substitutes, and the soft waste grease which formerly could only be used sparingly in soap on account of their softening effect can now be employed alone as soap stock. The importance of this is understood when the soaring prices of animal tallow are taken into consideration.

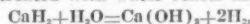
In view of the impending exhaustion of the Chile nitro beds, the problem of the fixation of atmospheric nitrogen for the manufacture of artificial fertilizers has received constantly increased attention. Electrical methods for the production of cyanimid from calcium carbide and nitrogen, and the flaming arc process for making nitric acid directly from the air have been established upon a successful commercial footing, but these require such an enormous expenditure of energy that they can only be operated profitably where there is an abundance of cheap water-power. If only these processes were available, countries lacking in water-power would be placed at a distinct disadvantage, and for this reason many chemists, particularly those of Germany, have labored to find a process better suited to the conditions surrounding them. The details of this search were described in a most interesting manner before the Eighth International Congress of Applied Chemistry, by Hofrat Dr. H. A. Bernthsen, who is the Chemical Director of the Badische Anilin und Soda Fabrik, the owners of a synthetic ammonia factory now in successful operation at Oppau.

The process, which has been named after Haber, its inventor, consists in passing a mixture of pure nitrogen and hydrogen under a pressure of 150 to 250 atmospheres through a tube filled with a catalyzer and heated to 650 deg. to 700 deg. Cent. The hot gases then pass through a heat regenerator and thence through an ammonia absorber, after which they are replenished with fresh gas mixture and forced by a pump back over the outer walls of the contact tube and then through the contact mass to repeat the circulatory course already described. Only a part of the gas mixture is converted into ammonia by a single passage through the converter, but the gases are made to circulate continuously through the apparatus, the ammonia being absorbed each time as the mixture issues from the heat regenerator at the end of the contact tube. The gases are replenished with fresh hydrogen-nitrogen mixture as required. The contact mass consists of pure iron containing small amounts of certain so-called promoters which may consist of oxides, hydroxides, or salts of the alkalis or of the alkaline earths, and also many other substances of the most varied nature, especially metallic compounds or the metals themselves.

There have been many ways proposed for the producing of hydrogen on a large scale, the most important of which are the electrolytic and the water gas process. The studies of A. Wegener and others lead to the belief that at an altitude of about 75 miles the atmosphere consists of pure hydrogen and nitrogen that would be ideal for the Haber process. Unfortunately no means of piping these gases down to our sphere of action are known and we must content ourselves with more laborious methods of production.

At European army posts, hydrogen for military balloons is commonly generated from scrap iron and sulphuric acid, the reaction being accelerated by heating the mixture to about 55 deg. Cent. For field operations zinc is used in place of iron and the generators are mounted on wheels to facilitate transportation. Three other, and more modern means, of generating hydrogen are used for field purposes and will no doubt be adapted for other than military uses in places difficult of access where the gas is needed. These processes were invented by G. F. Jaubert, a Frenchman, and were named by him respectively, the "Hydrolith," "Silicol" and "Hydrogenite" processes.

Hydrolith is formed by heating metallized calcium in an atmosphere of hydrogen, producing a hydride, CaH_2 , which when treated with water reacts as follows:

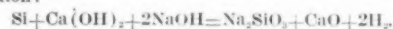


just as calcium carbide generates acetylene. Hydrolith is a white crystalline powder, decomposing at 600 degrees in a vacuum, and usually contains about 90 per cent of CaH_2 , the rest being nitride and oxide. One kilogram yields about one cubic meter of hydrogen. The apparatus designed for using hydrolith in the French army is very ingenious, can readily be transported and has a capacity of 1,200 cubic meters per hour. An army dirigible can be filled in four hours. The high cost of hydrolith, \$1.33 per kilogramme, will at present seriously restrict its use outside of military operations.

The Silicol process consists in treating powdered ferrosilicon, or mangano-silicon with water and caustic soda. It does not appear to have gained extended use because of the more troublesome manipulations and the greater difficulty of controlling the evolution of gas as compared with the other methods.

Hydrogenite is composed of ferrosilicon (containing 90 to 95 per cent of metallic silicon) 25 parts, caustic soda 60 parts and dry slaked lime 20 parts. The ingredients are reduced to a very fine powder, intimately mixed, and pressed into brick weighing 25 to 50 kilo-

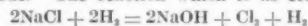
grammes. Being very hygroscopic, each brick must be sealed in a tin box to prevent decomposition. In generating hydrogen the brick is placed in a metal chamber having double walls, the space between the two walls being filled with water. Vents are placed in the upper part of the inner wall leading to the central chamber containing the hydrogenite so that the steam formed during the combustion may gain access to the charge and increase the yield. The cover of the tin containing the hydrogenite is opened, the tightly fitting lid of the generator fastened in place and through a small hole in the latter a red hot wire is thrust into the charge. The mass burns quickly, without flame, generating heat and evolving hydrogen according to the equation:



One volume of the compressed hydrogenite yields 800 volumes, or 270 to 370 liters per kilogramme, of pure hydrogen, at a cost of about 32 cents per cubic meter. The requisite apparatus for field purposes weighs about 900 kilogrammes.

The methods employed upon a large scale are, of course, capable of producing the gas much more cheaply. In one of these an iron, clay lined retort is filled seven-eighths full of coke, ignited and raised to a white heat by an air-blast. The retort is then closed and a cheap hydrocarbon like crude petroleum or coal tar is injected into it from the top for about 20 minutes or until the temperature has fallen below the proper cracking point, the gas thus generated passing through a sprinkling tower and filtered into the gasometer. The oil injector is then shut off, the retort opened, the air blast again turned on, and the process repeated indefinitely with periodical renewal of the coke and removal of the ashes. The product contains about 2.7 per cent CO , 96.0 per cent H_2 , and 1.3 per cent N_2 , and has a specific gravity of 0.1. The gas can be still further purified to a content of 98.4 per cent H_2 , by passing it through suitable absorbents, and is produced at a total cost of 3 to 4 cents per cubic meter, according to the size of the plant and the materials used.

Large amounts of hydrogen are obtained as a by-product in the electrolysis of salt solutions in the manufacture of chlorine and of caustic soda. The electrolysis is effected in a cell having a cement diaphragm which is not attacked by chlorine or caustic soda. The electrodes are iron and carbon, the latter being used as an anode. The reaction which is as follows:



yields 7,000 cubic feet of hydrogen for every ton of salt. A cell operates on 15,000 horse-power at Griesheim, Germany, producing 245 million cubic feet of hydrogen per annum.

Two other methods, now little used, consist, (1) in passing superheated steam over red hot iron, and (2) in conducting water gas through suitable absorbents so that the carbon monoxide and hydrocarbons are removed, leaving behind the hydrogen and nitrogen. A third process which is increasing in application was devised by Linde, Frank and Caro. In this, water gas which consists mainly of carbon monoxide and hydrogen is compressed and cooled to the liquefying point of the carbon monoxide. Upon relieving the pressure the mixture expands and in so doing is cooled still further so that the carbon monoxide and most of the impurities separate out in liquid form, allowing the hydrogen to pass off in a fairly clean (97 to 98 per cent H_2) condition. The mixture containing the liquid carbon monoxide is later vaporized and used in combustion motors for power.

The growing demand for cheap hydrogen for industrial uses will act to promote improvements in both the electrolytic and the water gas processes because both require comparatively cheap raw material.

* The Chemical Engineer.

Electric Waves and Oscillations*

A Means of Investigating the Interior of the Earth

By Dr. Gotthelf Leimbach

THE attempts—which have, until very recently, been unsuccessful—to utilize electric currents and waves in the investigation of the interior of the earth extend back, respectively, to the years 1830 and 1901. The first practical results in this field, attained by Heinrich Löwy and myself in 1910 and 1911, attracted by no means the attention in mining circles that we had anticipated. Even at the present day, in the face of a great number of successful achievements, many persons are still skeptical about the development of electrodynamic methods of exploring the earth. Judging from my experience, this is due especially to the fact that neither the physical basis nor the scope of the various processes in question are correctly understood. Wireless telegraphy, the most familiar application of electric waves and oscillations, is commonly accounted one of the marvels of modern times; while the application of the same phenomena to subterranean exploration is consigned to the realm of fable. In the following remarks I hope I may be able to convince the reader that the latter application is neither impossible nor incomprehensible.

The physical principles involved in this subject were discussed in detail in the journal *Kali*, volume 7, 1913, No. 17. I there explained the principles of the wireless transmission of electrical energy through space, in order to save practical mining men the necessity of consulting a work on wireless telegraphy. Hence, I shall in the present article limit myself to a short sketch of the various processes.

The possibility of applying electrical waves and oscillations in the investigation of the earth's interior depends upon certain physical differences in the materials constituting the earth's crust. The latter fall into two classes, according as they conduct electrical currents, or, on account of their slight conductivity, are classed as insulators. Good conductors of an electrical current are impervious to electrical waves, whereas the latter pass almost unaffected through insulators.

As electrical waves differ from light-waves only in wave-length, optical phenomena may be directly reproduced by the former. With an apparatus for emitting waves (a sender) and one for recording them (a receiver), we may make qualitative observations on the material lying between the two instruments. As stated above, materials that are conductive to an electrical current will not permit the passage of the waves. Among the conductors are water, salt solutions, and strata saturated with these; also a large number of ores.

I. INVESTIGATION BY MEANS OF ELECTRICAL WAVES.

a. Absorption Method.

A first practical method of investigation, the absorption process, takes the form of testing rocks for the presence of various substances by examining their capacity for admitting the passage of electrical waves. Practical investigations of substances which are opaque to such waves (ore and salt solutions) were made by Dr. Löwy and myself in the state mine of Ronnenberg, near Goslar, and also by Dr. Löwy at Scharley. These confirmed the fact that good conductors of an electrical current are opaque to electrical waves. A fair agreement with the theory, i. e., absence of marked absorption, was yielded by the rocks occurring in potash mines; viz., various salts, anhydrite, clay, etc. Numerous investigations in a large number of mines proved that there could be no doubt about the transparency to electric waves of the rock-forming minerals constituting the earth's crust—the ores excepted—when these substances are dry.

b. Reflection Method.

The reflecting power for light-waves of a great number of substances is as accurately known as their various degrees of transparency. Among the excellent reflectors of electrical waves we find, again, the substances that are conductive to an electrical current, viz., metals, ores, salt solutions, and water. With senders and receivers of electrical waves which have their antennae so arranged as to send or receive only in a selected direction it is possible, therefore, to locate these conducting substances through intervening material that is transparent to waves, merely by changing the direction of the antennae. From the angles between the antennae of the sending and receiving instruments, respectively,

* Translated from *Zeitschrift des Vereines deutscher Ingenieure*.

† Pure water is a non-conductor. The author's statement is, however, true of all water found in nature, this being conductive in virtue of the substances it holds in solution.—Translator's note.

and the ground when the intensity of the signals received is greatest, the depth of the reflecting layer (ore or water) can be computed. Practical investigations at the swimming hall in Göttingen, and also at Barsinghausen and Scharley, have proved the strong reflecting power of water and ore.

c. Interference Method.

In many cases, e. g., in determining the location of a water-bearing seam in the interior of a mine, it is impossible to use long antennae, movable at will. Such a seam may, however, be located with stationary sender and receiver if the wave-length of the system is so chosen that the waves running directly from the sender to the receiver are neutralized by those reflected from the conductive substance. This will happen when the path of the reflected waves is longer by $\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$, etc., wave-lengths than that of the direct waves. The two trains of waves have a different direction of oscillation, and opposite phase; their effect upon the receiver will be null in case they have equal energy. On the other hand, if the difference between the length of path amounts to one or a number of whole wave-lengths, the waves will then be of the same phase and their effect upon the receiver will be reinforced. As we are able to vary at will the wave-length of a sender and a receiver, we can ascertain by this method, as by the others, the presence and the depth or distance of a conductive reflecting seam. Experiments of this sort on a small scale were made by the writer many years ago in connection with investigations of quite a different character, viz., the study of moist soils, at the geophysical institute of Göttingen University.

d. "Quarter-wave-length" process.

In the method above outlined both a sending and a receiving system are used. About a year ago it occurred to me to ascertain whether the wave emitted by the sender and returning thereto after falling vertically upon a reflecting surface would not affect the oscillations of the sender in a manner analogous to what occurs in the interference method. A method depending upon this principle would have the advantage of great simplicity, as compared with the interference method, because it would eliminate the second receiving system. In the laboratory of the "Erforschung des Erdinneren (G. m. b. H.)" ("Subterranean Investigation Company, Ltd.") at Göttingen, experiments on a small scale gave the surprising result that reflecting surfaces could be located the length of which was less than that of the antenna and the breadth only one hundredth the length of the antenna, or less. This method is, therefore, extremely sensitive. As the sender shows particularly characteristic effects for differences of a quarter of a wave-length or multiples thereof, this process has been called the "quarter-wave-length" method. From the position of the characteristic maxima and minima of the effect of the reflected waves in relation to the wave-length the depth of the reflecting layer may be very accurately determined. This method is appropriate for seeking ore or water from the earth's surface in all cases where the intervening strata do not wholly absorb the waves. An expedition sent out by the company above mentioned, under the auspices of the Imperial Colonial Office and other interested parties, is now engaged in prospecting by this method in Southwest Africa.

II. INVESTIGATION BY MEANS OF ELECTRICAL OSCILLATIONS.

The following methods work with a single system of apparatus and depend upon the influence exerted on the apparatus by its immediate environment. The quarter-wave-length method therefore forms a connecting link between the methods in which the course of electrical waves is followed between two stations and those which involve observations of the influence exerted by the environment upon the oscillations of a single system.

a. Capacity and Damping Method.

The wave-length, λ , of an oscillating system, e. g., of an antenna, is determined by the latter's self-induction, L , and capacity, C , according to the relation $\lambda = 2\pi\sqrt{LC}$. The surroundings of the antenna have no influence on the self-induction, which therefore need not be considered further. On the other hand, the capacity of an antenna is strongly affected when the lines of force running from the positive to the negative end of the antenna pass through some medium other than air. Each substance possesses its own dielectric constant—a number analogous to specific gravity—which shows how many times the capacity of an electrical system is increased when operating in the substance in question

instead of in air, the dielectric constant of which is unity.

The use of this principle of various dielectric constants in different substances seems quite pertinent when we learn that water has a constant of 81, while most rocks have constants varying between 4 and 12. We may therefore assume that the presence of a water-bearing seam will make itself felt through an increase in the capacity of the antenna, even at considerable distances. That even the slightest differences in the dielectric constants of various rocks occurring in potash mines cause differences in the capacity of oscillating systems has been determined through the detailed investigations of Dr. Erich Mayer and myself.

A great advantage of this method consists in the fact that substances having different dielectric constants affect not only the wave-length but also the damping of the oscillations in different degrees. In conductive substances energy is used up in the production of vortical currents, and to these substances belong, as we have said, water and salt solutions. Non-conductive substances of high dielectric constant virtually affect only the capacity of the system. Hence, this method should permit not only the discovery of the presence of substances of different dielectric constant, but also at least a qualitative identification. Thus we have the basis of a method which can be applied, first of all, in mining and shaft-sinking, to the task of determining whether there is danger of an irruption of water or salt solutions.

b. Examination of Frozen Shafts.

Water-bearing and unstable soils are now, with increasing success, frozen in connection with shaft-sinking, in order to produce a cylinder of resistant material within which the sinking of the shaft can proceed without danger. That this operation has not always been successful is due to the fact that it has hitherto been difficult to determine whether the frozen layer was sufficiently solid at all points. The efforts to remedy this difficulty have been limited practically to the construction of more or less trustworthy sounding-devices for testing the behavior of the various freezing-pipes. From the behavior of any two successive pipes, and with the aid of the data deduced from past experience, it is decided whether the amount of cold applied is sufficient to freeze the section of ground between the pipes, or whether a supplementary freezing-pipe ought to be installed between them. Moreover, in order to freeze with tolerable certainty any strata containing salt solutions, which have led to many breaks and accidents, very low temperatures are used. In spite of all improvements, the fact remains that there has heretofore been no means of promptly detecting the presence of disturbing factors within the earth. Here again the aid of electrical oscillations may be invoked. Unfrozen water-bearing or solution-bearing seams lose their electrical conductivity in proportion as the water they contain is changed to ice. Hence, the iron freezing-tubes must be used as antennae and made to give rise to electrical oscillations, which will be effected by the immediate environment in the same manner as in the capacity method. Experiments on a small scale confirmed the utility of this process; ice was found to be transparent to electrical waves. The conductivity of water containing a small admixture of salts was reduced to about $\frac{1}{100,000}$ of its original value by cooling from room temperatures to 10 degrees below zero Centigrade.

Meanwhile it remained to be determined whether these assumptions would be as perfectly realized in an actual shaft-freezing operation, with its envelope of frozen soil, as in experiments on a small scale. We had no difficulty in transferring our laboratory experiments to the practical conditions of such an undertaking. My collaborator, Dr. Mayer, and myself were able within a few minutes to excite oscillations of a previously determined wave-length in any freezing-tube we happened to select, at an installation between Rössing and Barnten where the necessary facilities were kindly placed at our disposal by the "Tiefbau- und Kälteindustrie A.-G." of Nordhausen (formerly Gebhardt & Koenig). The last preliminary condition of the proposed method was thus fulfilled; the frozen envelope of the shaft gave an effect exactly analogous to that produced under artificial conditions in the laboratory.

Our request for permission to continue our experiments at the Glitten shaft was cheerfully complied with by the "Deutsche Schachtbau-Aktiengesellschaft" of Nordhausen. With funds raised on the strength of our success at Rössing-Barnten, we only succeeded in test-

ing the frozen wall of the shaft so far as to discover, at the outset, the presence of an unbroken layer near the surface, which hindered the penetration of the electrical waves to the lower end of the freezing-tubes. This layer, according to our measurements, lay at a depth of barely 2 meters. Subsequent investigation showed that a thin layer of the freezing-mixture lay upon the cement block in which the drive-pipes were installed, and this had not frozen.*

Had not the shaft been, for the most part, already lined with iron, we should have been able to apply successfully here a method which we have applied, with good results, in a Hanoverian potash mine, where we had to work through a much more strongly conductive layer than the one above mentioned. However, both here and also a few weeks later in a shaft-freezing installation kindly placed at our disposal at Heerlen, Holland, by the "Deutscher Kaiser" Mining Company, we had to content ourselves with the positive result of having been able to detect not only the presence but also the depth of an unfrozen seam, which lay even deeper at Heerlen than in the case just referred to.

Recognizing the fact that we must, for the future, generally expect such layers of disturbance near the earth's surface, and a more or less extensive iron lining in the shaft, I endeavored to devise another method in which the investigation of the freezing wall of the shaft would be entirely unaffected by such obstacles. The ample equipment of our physical laboratory greatly facilitated this undertaking. Setting out from certain very definite experimental conditions, my colleagues, Drs. Mayer and Kröncke, and myself succeeded in exciting electrical oscillations in two bare wires buried in wet earth—representing a freezing-tube system on a small scale—and in determining the constants which furnish information as to the separation of the tubes and the location of unfrozen places in the frozen wall. After experimenting under a variety of conditions we

came to the conclusion that the presence of a conductive layer under the sill of the superstructure, due to the often practically unavoidable spilling of the freezing solution in filling the tubes, and also the existence of an iron lining ("tubbing") in however advanced a stage of construction, need not interfere with the examination of the frozen earth; indeed, the iron lining can be turned to good advantage in connection with this process.

c. Investigations in Connection with the Cementation Process.

The use in shaft-sinking of the cementation process, in which crevasses in the wall of the shaft are closed by forcing cement into them, has steadily gained adherents notwithstanding numerous failures. Unquestionably this process has its advantages in many cases, especially when water needs to be kept out in comparatively small areas at great depths. While in the freezing process it is possible to form a tolerable idea, through various modes of observation, of the successful progress of the work, in the cementation process the measurement of the water flowing into the drill-holes, or of the amount of cement forced out by the water, furnishes the only method of testing the solidification of the dangerous crevassed strata. The strong outward resemblance of the cementation to the freezing process led me to consider the applicability to the former of the electrical method of testing for water. The method used in the freezing process could not be applied without modification, since in this case it was not a question of insulating the drill-holes from water-bearing seams. However, preliminary experiments at Göttingen and also in an actual shaft where cementation was in progress showed that the waves from a highly isolated antenna can penetrate so deep in the earth that from the reaction of the earth upon the antenna it is possible to gain a knowledge of the presence of water in crevassed strata. An advantage offered by the electrical

test consists in the fact that the antenna is not essentially affected by thin newly-formed layers which diminish the flow of water, take up little cement, and thus give a deceitful effect of solidity, but which, with further sinking of the shaft, do not offer sufficient resistance to the pressure, and thus may ruin the shaft. So long as the water is not effectually held back by the cement, so as to furnish the conditions necessary for forming a cement wall strong enough to withstand the very heavy pressures to which it may, under some circumstances, be subjected, the danger of a break may still be detected by our instruments, even in cases where the almost complete cessation of flow would, according to previous experience, apparently justify the further sinking of the shaft.

CONCLUSION.

The foregoing remarks will, it is hoped, help to give the reader some idea of the principles underlying the various methods of investigating the interior of the earth by means of electrical waves and oscillations, and to stimulate his interest in the practical results thus far attained. These results will be discussed in another article.

[In addition to the article in *Kali* mentioned above, several accounts of the methods of investigation described in the foregoing memoir have been published by Dr. Leimbach and his collaborators in German and Austrian scientific journals, the more important being:

H. Löwy and G. Leimbach, "Eine Elektrodynamische Methode zur Erforschung des Erdinnern (Erste Mitteilung)," *Physikalische Zeitschrift*, 11, 1910, p. 697 ffg. *Ibid.* (Zweite Mitteilung), *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 60, 1912, p. 627 ffg. and p. 640 ffg.

H. Löwy, "Systematische Erforschung des Erdinnern mittels elektrischer Wellen," *Zeitschrift für praktische Geologie*, 19, 1911, p. 297 ffg.—Editor of SCIENTIFIC AMERICAN SUPPLEMENT.]

German System and Method*

The Effect of the War on Her Industries

THE significance of the two words "system" and "method," and of all that these words connote, has been demonstrated to the full in the present war by the Germans, who, with much pride and satisfaction, make innumerable references to them in the press, in public meetings, and in private conversation. We all know that Germany, in every conceivable field, has carried her principle of systematizing to a length and degree of perfection unapproached and, perhaps, even hardly attempted in other countries, and however difficult her position may be at the present day and in the future, it would have been infinitely worse had she not had her system of systems to fall back upon. Its immense machinery was at once put in action, and the Germans claim for it that, when put to the tremendous test set it by the war, it has done all that could possibly have been expected from it.

At the recent general meeting of the Allgemeine Elektrizitäts Gesellschaft a statement was made that "the first task for the German industry, which through the war had experienced an unprecedented 'narrowing in,' was that of standing on its legs. To do this, a transformation of the entire industry was to some extent necessary. Although it certainly was by no means a simple matter for a country with many imports suddenly to get substitutes, the necessary transformation or alteration within the whole industry has been completed with admirable ease." Commenting upon these remarks, a writer in a Berlin journal says this only confirms what every day and every hour they see and hear and read. There is hardly an industrial report which does not bear out that, after the shock, work has been resumed with 40, 50, or 70 per cent of the usual staff, and that part of the work, directly or indirectly, has been devoted to war purposes. A factory for incandescent lamps all at once took up the manufacture of cartridges; machine works made "Guillash-cannons"; a maker of artificial flowers went in for bread-bags, a Bijouterie concern for knapsacks; a hotel kitchen was turned into a jam factory. It only took a couple of weeks, and the necessary plant was available. Hands were trained, and energetic merchants looked to the supply of raw materials, or where the usual ones were unobtainable, of substitutes, and to means to bring producer and buyer in contact, though often by a roundabout way. The system has worked admirably, and at a time when people were compelled to work with the utmost economy it has managed to call forth from the darkest and narrowest corners raw materials, to secure that nothing was wasted, and that no possibly accessible foreign source of supply was neglected. The fact

that a number of earnest and financially strong business men were compelled to apply themselves to opportunistic dealings has also helped to augment the exceptional work done in this connection.

In examining into the reasons why German industry has escaped being brought to a standstill by the war in nearly every one of its more important sections and, after a short reorganization and with partly altered objects in view, has worked on with an imposing certainty and without any suspicion of nervousness, it becomes clear that the most potent factor is that the German army quickly succeeded in carrying the war into foreign countries. In addition to this, the industrial and financial authorities succeeded, by wise measures, in establishing confidence in the power of resistance of the German industrial organization, which, in its turn, rested upon the German military successes. The causes of the uniform continuity in German industrial growth, however, in the last instance are to be found in the fact that German development, more than that of any other country, has grown systematically, and shows no gaps of any moment in the manufacturing processes. With regard to certain raw materials which the German soil does not produce, or, in any case, not in sufficient quantities, Germany will also in the future have to depend upon foreign countries, even if the efforts of its scientifically working industry are systematically centered upon replacing artificially the natural raw materials which Germany lacks. In this connection mention is made of the successful attempts at producing artificial nitrogenous manure instead of Chile nitrates, at producing home-manufactured benzol in place of foreign benzine, and of the not yet quite successful attempts at producing artificial leather and rubber.

Still more important than the raw-material question for the maintenance of the collective German industry under the present conditions is the fact that no indispensable intermediate link is missing in the large processes of production. Germany produces herself all her half-finished goods, and she utilizes the residuary products of her industrial processes for the manufacture of valuable auxiliary commodities with such financial results that no other industrial nation in the world even approaches her in this respect. What these auxiliary products mean to Germany at present is more especially demonstrated by sulphate of ammonia and benzol. How much the want of important links in production can harm a country in her industrial processes is demonstrated in England, where the inadequate development of many auxiliary and vital industries has almost crippled some of the country's chief lines of manufacture. Thus, the stoppage of the German dyestuff import,

which, in money, only represents about a million sterling, threatens the English textile industry, the English wall-paper industry, and many other branches, with a turn-over of many millions. In the same way the absence of cheap German half-finished goods has deprived the English iron industry of an important intermediate link. Further, the stoppage of mining timber has gravely inconvenienced the collieries.

Industrially, the long established and growing British principle of producing entirely finished goods, and importing the raw and intermediate products of great industries, has proved inferior to the German method in time of war. This latter aims at a complete organization of an entire manufacturing process in comprehensive works, which, separately or together, cover the entire series of operations needed. The industrial expansion of Germany, although it is much younger than that of England, has been laid out on more systematic lines, and in such a way as to render the country more independent of foreign aid. Under the difficult and strenuous conditions of war it has demonstrated the extreme value of system and method, and the advantages which they confer on a nation when it is cut off from the lands from which it draws its raw materials.

The Government to Certify Timepieces

THE test and certification of watches, chronometers, and other timepieces has been carried on for many years at the Kew Observatory in England, at the Besancon Observatory in France, and at the observatories of Geneva and Neuchatel in Switzerland, but no such tests have been made for the public in this country, except for a few years at Yale University many years ago. This line of work is now started at the Bureau of Standards, and Circular No. 51, entitled "Measurement of Time and Tests of Timepieces," has just been issued giving the regulations under which the tests will be made, the methods employed, together with sections on the use and care of watches, and on standard time and the sources of reliable time standards with which one may make frequent comparisons of his watch. This first edition of the circular announces the regulations for the test and certification of watches only; the test of other timepieces will be taken up later. It is expected that the tests will be especially valuable in cases where watches are to be used for scientific purposes or exploration, and also to purchasers of high grade watches in giving them assurance that the watch is reasonably adjusted and in good condition at the time of the test. Copies of the circular and also of the application blank may be obtained upon request from the Bureau of Standards, Washington, D. C.

* From *Engineering*.

The Hydraulic Mining Cartridge*

A Mechanical Device for Use Where Explosives Are Impossible

By James Tonge, M.I.M.E., F.G.S.

THE difficulty of removing rock and other material, in places where the shock attendant upon blasting operations would be damaging and dangerous to surrounding strata or foundations, is one which has not hitherto been thoroughly overcome.

The enormous initial power generated by the sudden decomposition of explosive substances has enabled great quantities of natural or artificial beds to be displaced, and a great portion of the work of the civil and mechanical engineer is involved either directly or indirectly in operations of this kind. The objection to the use of explosives, however, in many circumstances, is that the effect of blasting can seldom be harnessed or controlled so as to prevent the disintegration of the material beyond the area which it is desired to dislodge. In the case of many metalliferous mines, and sometimes of quarries, this is not a great drawback as it may not only be unnecessary to limit the operation of the "shot," but it may be actually desired to have the material in a pulverized condition. Even in this case, however, it should be remembered that this is not an economical means of

to operate at the back of the hole first, the wedge being drawn towards and not driven from the front. Except in the case of the simpler forms it may be said that no mechanical wedges are now being used with success for excavating purposes of any kind.

The Hydraulic Mining Cartridge.—The hydraulic mining cartridge differs from all other mechanical substitutes for blasting. It is not worked on the principle of the wedge, and consequently the power expended in forcing a wedge into the hole is saved. Instead of employing

done by having the piston (e) operated by the piston rod (f) which passes through a supplementary or hollow rod (g) and has an appropriate handle for operating the piston within the pump cylinder. By these means the piston may be quickly reciprocated by the user moving the small handle until the desired quantity of water has been supplied or until the pressure to be exerted over the rod (f) is beyond the power of the user, when the supplementary rod (g) may be brought into use to finish the operation, this advancing by screw motion, and great pressure being obtainable in this way.

Method of Working.—After the rock or coal has been prepared with one or more loose sides and the drill hole of 3 inches, 3½ inches, or 4½ inches, has been drilled to a suitable depth (say three or more feet), the cartridge is pushed in with liners if necessary. The water tank is filled and hung on the pipe, the rubber suction pipe coupled, and the taps turned. The small handle and then the large one are operated as already described. The pressure being fully on, the enormous power of the apparatus is soon apparent, for the rock or coal is heard to



Fig. 3.—Operating the hydraulic cartridge in a coal mine.

obtaining such a result, for pulverization by explosives involves enormous waste of power as it usually represents great excess of explosive charge; in other words, the use of explosives must involve either the risk of accident through an insufficient charge or the production of misapplied energy.

It is for the purpose of avoiding these drawbacks and in order especially to take greater advantage of natural lines of cleavage or of bedding in the material to be dislodged that efforts have from time to time been made to provide what may be termed more rational or scientific means in the shape of mechanical substitutes for blasting.

The simplest form of mechanical means for breaking ground is, of course, the wedge, and this is used in varying lengths and shapes, in metalliferous and in coal mining, in all parts of the world. Various improvements on the simple wedge have been used at various times, viz., the stub and feather and the multiple wedge. The former consists of a steel "stub" or wedge driven in between two tapered liners of steel called "feathers" which have their thin end near the front of the hole. The multiple wedge is placed in a hole previously drilled and has liners also, but a pair of "feathers" may be inserted between them, driven up as far as possible, and then a second or a third "feather" may be used until the rock or coal is broken down. In coal mines, special efforts have been made to devise mechanical wedges capable of breaking down coal, notably those invented by Bidder, Burnett, Shreeve and Hall, and these have been used to a greater or less extent in a few mines. In some of these the wedge was driven in by means of a screw and handle, like a hand drilling machine, and in one case by hydraulic power.

These machines are not now in use and it may be taken that they have proved to be impracticable. This is no doubt due to the great pressure put upon them, even under favorable conditions, and the difficulty of devising and supplying a hydraulic pump capable of working at high pressure for a considerable time. It must also be remembered that a mechanical wedge must perform more work than that required to wrest the rock or coal from its position, as a certain amount of power is consumed in overcoming the friction of the sides of the wedge as it is driven up. Again, it is a disadvantage to have the material at the front of the hole breaking away as the wedge enters—the full weight of the falling material should, if possible, be utilized to assist the operation. With this object in view, machines have been designed

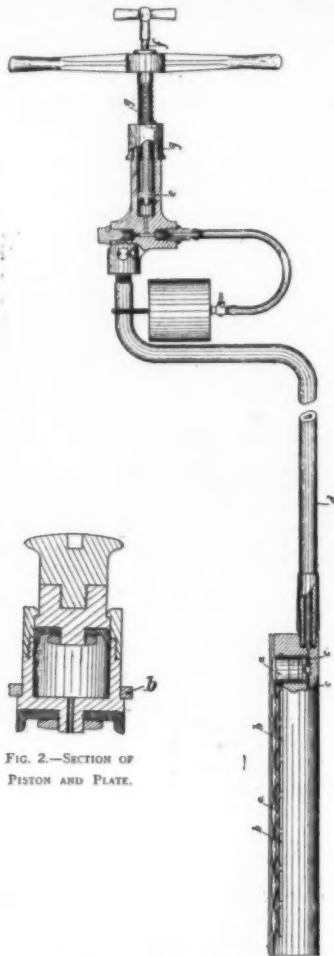


Fig. 1.—Sectional elevation of the hydraulic mining cartridge.

a wedge, the disrupting effect is obtained by means of a number of small rams or presses working at right angles from a strong cylinder of steel. (Fig. 1.) In order to make these rams more effective in their operation, by obtaining a greater travel from their original position, they are made of a duplex or telescopic form, one part sliding and fitting upon the other (Fig. 2). In some cartridges these pistons operate from each side of the cylinder alternately, thus greatly increasing the travel. To retain the rams in position, a sliding plate is used fitting in grooves in the barrel (b Fig. 1); this is so formed and secured that it is perfectly rigid and firm when the machine is in operation, but is readily removable if it is desired to detach or replace any of the rams. By a suitable arrangement of passages (c Fig. 1) a communication is made between each of the rams, whereby simultaneous action is obtained. Machines are made of various diameters, viz., 2½ inches, 3¼ inches, and 4 inches, and of various lengths, say with 8, 6 or 5 rams, the smaller diameters having the larger number of rams. Pressures of 3, 4, or 5 tons per square inch are usual, so that machines are made to withstand great stresses.

The Pump.—The cartridge is operated by means of a pump (Fig. 1) to which it is directly connected by a pipe (d). The pump is of special design. At the commencement of the supply of water it is desirable that the latter should be supplied in such quantities as to fill up quickly all the spaces within the rams and passages, while at the same time allowing the operator, when the rams begin to move and the pressure to increase, to supply a less quantity of water, but at a greater pressure, to complete the final operations of the rams. This is



Fig. 4.—Effect of hydraulic cartridge on rock in mines.

be rumbling and cracking. This is allowed to continue until the breaks are of such a size that the mass can be pushed or pulled over and usually is in such condition as to be easily and safely handled.

Line of least resistance.—It is easy to understand that when a shot is fired in rock or concrete, the direction of the breakage will be chiefly in the line of the weakest part. If the material is of uniform strength this direction would be a straight line from the explosive to the nearest unsupported edge. But stratified beds, seams of coal, and walls of stone or brick, are not usually of uniform strength; rock and coal beds contain breaks, cleats, and faces, while concrete beds are invariably irregular in constitution or structure. It follows, therefore, that the line of least resistance is not necessarily the shortest line from the charge to the surface. The difficulty and danger of explosive firing is that whatever this line may be, it is not often possible to make use of it; the pressure generated, though not equally effective, is equally applied in all directions owing to the instantaneous character of the decomposition. This involves high temperature in the explosive gases, a large portion of the heat being absorbed and wasted in the portions which are not capable of being blown down. When mechanical means are employed the time involved in the operation allows the whole of the power to be exerted and applied in the desired direction without waste of heat energy. Not only is power lost in heat energy in the case of explosive compounds, but the result often proves that there has been counter action whereby the rock displacement is reduced through one line of force operating against another, closing in or reducing the area of broken ground.

In practice it is found possible so to arrange the hydraulic cartridge holes as to enable much greater areas of material to be moved than could be done with a safe quantity of explosive, while in some cases the displacement has been greatly extended by the use of small-sized bore holes toward which the slowly developing line of least resistance can assert itself. In other words the power exerted by the rams can be controlled, after a little experience, so that the full pressure can be usefully applied.

Use in Mines.—The appliance was originally introduced into mines in order to supply the acknowledged need of a different method for bringing down coal in mines in the best possible condition after it had been undercut by hand or machine. The use of high explosives for this purpose, apart from the element of danger, has

* From the Journal of the British Society of Engineers.

always been considered undesirable by mining experts, because in using them coal is shattered and wasted and dust made. Now that coal has to be won from greater depth than formerly, and the distances and areas underground increase, the dangers and extent of explosion have proportionately increased, as many recent colliery disasters have shown. The mines in which the cartridge has been chiefly adopted may be divided into two classes:

- Where the coal is so friable as to render the use of explosives impossible for commercial reasons.
- Where the condition of the mines in regard to gas,

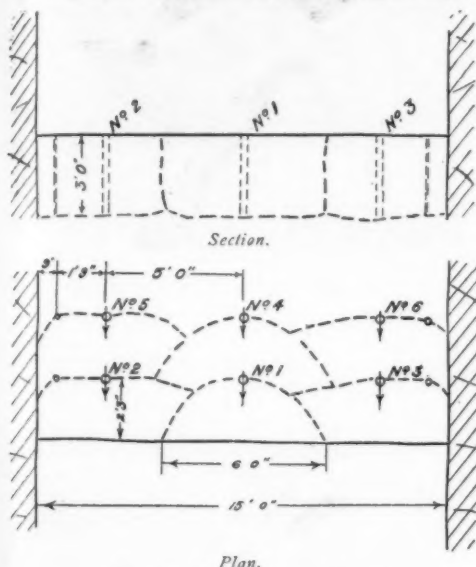


FIG. 5.—TRENCH EXCAVATION.

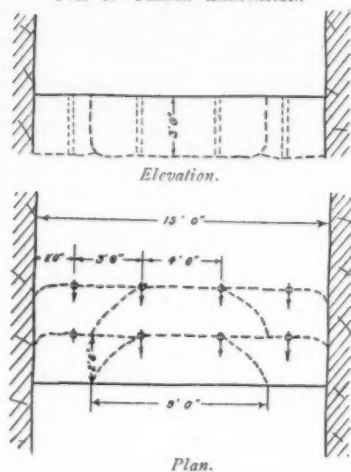


Fig. 6.—Trench excavation.

etc., renders shot firing an exceedingly dangerous proceeding.

Of course the question of cost enters very largely into the matter. As is usually the case when a new appliance is introduced, its qualities are quickly estimated from the effects upon the working expenses. At a later stage it will be seen that its effect upon the working cost is slight, while its general advantageous effect upon the selling price of the coal is quite striking. During the past ten years the appliance has been employed in mines in Great Britain, the United States, Russia, Japan, Germany and Austria.

In removing coal a series of holes is drilled in the top of the seam, adjoining and running parallel with the roof. These holes are at intervals determined by working conditions, usually from 6 feet to 10 feet apart and from 3 feet to 5 feet deep. The operator begins at the first hole and pumps off each in succession, usually leaving the supporting sprags to be removed by the collier, who fills the coal thus broken and prepares the coal behind for a repetition of this process. One operator can pump from 30 to 40 shots per working shift of eight hours, using only one machine, which lasts with repairs from three to four years. This procedure is adopted where a large wall of coal has been opened out, and where the coal is got in pillars and headings the process is somewhat modified. The coal across the face of the heading in undercut (almost universally now by a percussive machine operating from a fixed standard) and a vertical slot or "shear" is cut up the center of the coal, thus providing a loose end. One hole on each side of the "shear" is then sufficient to bring down the coal. The holes are placed as near as practicable to the fast side in order to bring the coal down as near the "fast-corner" as possible. (Figs. 3 and 4 show the cartridge in use in mines.)

Among the mines in which these machines are at present in use are the following:

Colliery No. 1.—At this colliery an average of over 1,000 explosive shots per week were formerly fired in coal in the various mines. By the introduction of the hydraulic cartridge the whole of the explosive shots have been discarded and there is not now a single shot in coal in any seam. In one seam alone a total of 28,500 hydraulic cartridge thrusts were made in one year, by which it is estimated that 92,626 tons of coal were produced, or about $3\frac{1}{4}$ tons per thrust. The seam was 3 feet thick and four cartridges were in daily use.

Colliery No. 2.—In a seam using five hydraulic cartridges 450 tons of coal are produced per day, of which 75 per cent is large coal and 25 per cent small. When the coal in this seam was brought down by explosives the percentage of large coal was 65 per cent and the percentage of small was 35 per cent. The average price of large coal was 13s., and of small coal 7s. per ton. The profit obtained by the use of the cartridges on this seam on 450 tons is therefore £14 5s. per day. Fifteen machines are employed at this colliery, making a total advantage over explosives of £42 15s. per day. Moreover, an extra 6d. per ton is obtained for the coal brought down with hydraulic cartridges, on account of its greater hardness and freedom from dust.

Use in Reservoirs, Docks, Harbors and Canals.—The operations in these places have all certain features in common which allow of their being classed together, and they may be divided into three classes.

(a) **In open Trenches.**—The difficulty of removing rock from confined spaces where it is necessary that no shock or vibration should be transmitted to surrounding strata is a very vital one. The introduction of the hydraulic cartridge into this class of work will, it is hoped, help to solve this question. During the past few years it has been thoroughly tested under most varied conditions and in all classes of deposits.

The work in trenches usually proceeds as follows: A number of holes are drilled (Fig. 5), say 2 feet 3 inches back from the edge of the rock, about 5 feet apart and 3 feet to 5 feet deep, according to circumstances. The holes are, when possible, bored by a power drill operating from a tripod. By these means suitable holes, of diameters up to about 5 inches, can be quickly drilled. The center hole is pumped first and provides a loose end for those on each side. These are pumped in turn until the fast side is reached, where it may be found advisable to drill a small 1-inch diameter hole, say 9 inches from the fast side, to enable the cartridge to break the rock as

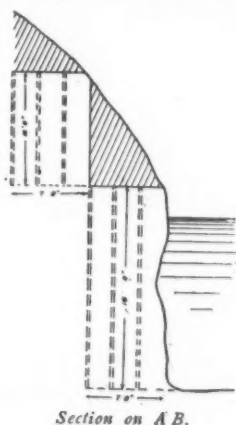


Fig. 7.—Excavation of rock on the side of a canal.

close to the fast side as possible. Sometimes this method is varied by pumping off two center holes simultaneously and placing the last holes 2 feet from the fast side, leaving out the small diameter holes. (Fig. 6.) In this case the holes could be 2 feet 6 inches from the front edge and two machines would be required.

Taking a trench 15 feet in width and holes 3 feet in depth, the first method would necessitate three cartridges and two 1-inch holes to get 100 cubic feet of rock, while the second method would require only four cartridge holes to remove 112 cubic feet. During the operation of the machine it is possible to see the rock slowly fracturing at each turn of the handle. Work of this character has been done by the cartridge in connection with the Derwent Valley Water Works, and the Cwm Taff Reservoir, Liverpool Corporation, and tests are now being made for the Abertillery Water Scheme.

(b) **Under Water.**—The appliance has been used in

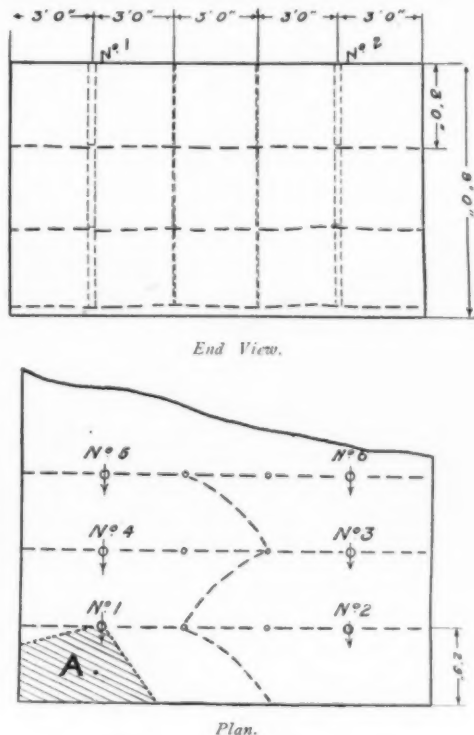


Fig. 8.—Concrete bed excavation.

many cases under water, chiefly to remove rock, either from the sides of canals, or from the sides of harbors and docks, where it was obviously impossible to use explosives, the machine being operated from the bank or from pontoons. A typical case will serve to illustrate the suitability of the cartridge for this class of work. The rock to be removed was partly projecting from the side of the canal, and it was necessary not only to remove the mass in the water, but also that upon the bank, as shown in Fig. 7.

The rock was New Red Sandstone and the depth to the bottom of the canal 18 feet. It was decided to remove the mass the full depth at one operation. A series of holes was accordingly drilled 6 feet apart, 2 feet 4 inches back from the edge, and 18 feet deep. These were pumped off in succession and the operation of the cartridge at this depth sufficed to break the rock right up to the bank in nearly every case. In one or two holes it was found necessary after operating in the bottom half to draw the machine up about 9 feet and operate again. During the operation divers were below water ascertaining the position and extent of the breaks and directing the operator above as to how to continue the thrusts. The portion shaded (Fig. 7) was removed by hand, and another series of holes was put down 10 feet deep, 6 feet apart, and 2 feet 4 inches from the edge, to break up that portion of the rock to be removed.

In the Alexandra Docks at Newport, and in the new dock at Swansea, the appliance has been used to break up ledges of rock occurring in the vicinity of walls which would have been damaged by the use of explosives. The holes were put in and the cartridges inserted under water by divers and pressure was applied from the pump placed on a raft on the water.

(c) **Dock or Harbor Walls.**—Hydraulic machines have been used for some years at the Dover Harbor Works for the purpose of detaching the large concrete blocks used in the harbor walls. These blocks are of great size and weight. By inserting the drill hole along the bottom of the block and placing the cartridge about half-way under it, the whole mass is slightly lifted and tilted without breaking, and being thus released from its bed is easily lifted on to a wagon by a crane. Machines are being used for a similar purpose in other docks.

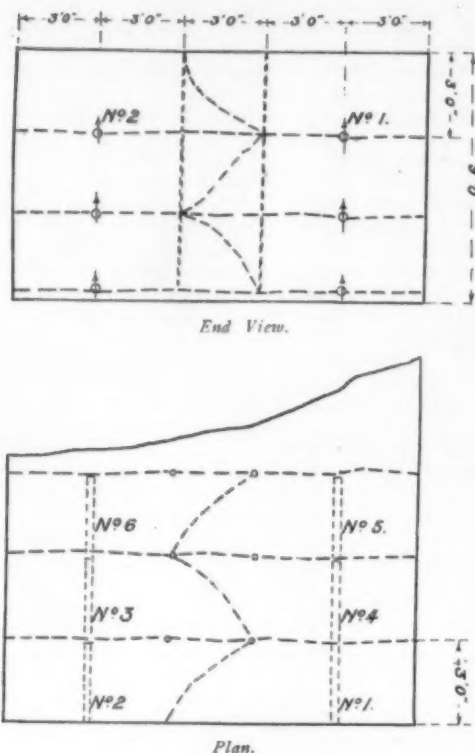


Fig. 9.—Concrete bed excavation.

Excavation of Foundations.—The question of the removal of concrete foundation beds by a method which would not involve explosive blasts and would avoid the slightest damage to machinery or buildings has been carefully studied recently by the writer, and had never been thoroughly solved until extended trials in all parts of the British Isles had been made.

The effect of powerful hydraulic pressure upon concrete is interesting. In the case of sandstone and shales there is comparatively slight crushing of the rock before the full pressure of the rams has the effect of causing the mass to bend; considerable pumping and consequent travel of the rams is then necessary before the rock finally begins to crack and break away; with concrete, however, there is usually a perceptible interval during which the rams are crushing or compressing the material and no movement is noticeable; after this is accomplished a few more thrusts of the rams cause the whole mass to break up without any indications of bending. It may still be necessary to continue to apply pressure and to increase the size of the breaks in the mass, but the greatest shattering effect will have been accomplished at the first disclosure of the cracks, the pressure required to break the mass afterwards gradually diminishing.

In such material, explosives invariably have the effect of "hacking a way through" by the shortest direction to the unsupported edge (Fig. 8), pulverizing the mass but failing to take advantage of pressure gently applied, by means of breaks which spread and widen, and to utilize the weight of the concrete itself to increase the scope of the operation. Numerous experiments in this class of work show that 60 to 70 cubic feet of concrete can easily be removed per thrust.

The general procedure in attacking beds of concrete may be divided thus:

1. By vertical cartridge holes.
2. By horizontal cartridge holes.

1. **By Vertical Cartridge Holes.** (Fig. 8.)—This method is most applicable to places where power can be easily obtained to bore the holes by tripod and power drills. The cartridge holes are drilled about 3 feet deep and 2 feet 9 inches back from the front edge of the bed. It has been found of great advantage to drill small diameter holes 3 feet away and in line, to which the fracture will break. In this way a bed 15 feet wide could be broken all across by two cartridges and two small diameter holes, amounting to 124 cubic feet of material.

2. **By Horizontal Cartridge Holes.** (Fig. 9.)—In this case the holes would be 3 feet deep and made to lift 3 feet of material per thrust, the vertical small diameter holes being put in as before. The amount of material moved per thrust is 67 cubic feet. The effect of lifting up is to break a larger quantity of material and in much larger pieces than is the case with vertical holes. With the latter the concrete is found to be very well broken up, and ready for handling without the further use of tools. Horizontal holes, on the other hand, are more suitable for beds where foundation bolts are embedded in the concrete.

There appears to be no class of work so suitable for this machine as the removal of concrete beds. The

following recent case is a typical example. At a municipal electricity works the cartridge was used to remove the main engine room foundation bed. Within a radius of 40 yards from the scene of operations, many of them within the same building, were very valuable Lancashire and water tube boilers, electrical and steam engines and the main switch board and cables. Needless to say the work had to be carried out with as little vibration or shock as possible. Explosives were out of the question, and the ordinary method of hammer and wedge would have proved an extremely long, tedious, and expensive process. The bed consisted of a solid mass 14 feet 6 inches wide, 26 feet long, and 10 feet deep, composed of hard cement concrete for the most part, and reinforced with numerous foundation bolts.

It was considered unnecessary to install power drills on the work and the holes in consequence were drilled by hand. The majority of these were horizontal and were put in by means of an ordinary twist drill and ratchet machine by two men. These men could drill fairly easily 3 feet per hour. One hydraulic cartridge only was employed. The general procedure was to keep the drillers at work putting in holes all round the side of the concrete, the machine following when two or more holes were ready. The holes were on an average 6 feet 6 inches apart, and from 2 feet 6 inches to 3 feet below the surface in the case of horizontal holes. The vertical holes were drilled only in special places to trim down the vertical edge, and in these cases the measurements were about the same. The employment of shot holes to form a breaking point was considered unnecessary. (Fig. 10 is a photograph of one of the horizontal shots.)

The debris thus broken was removed by a gang of six men who were kept busily employed with pick and shovel, and wedges were necessary only to break up the larger pieces to a suitable size for handling. It was found that the amount of material broken up in the course of three or four shots was quite sufficient, in consequence of the limited and cramped working area, to keep the men busily employed for the rest of the day. Had it been possible to place more men on the bed, there is no reason why a much better output should not have been attained, but in this case it would have been necessary to break open the wall in several places, which was not considered advisable. The whole bed, weighing approximately 200 tons of concrete, was removed in twenty working days. About sixty shots were necessary to complete the work, making an average of nearly $3\frac{1}{2}$ tons per thrust.

The cost of the work was as follows:

Labor per day, including operator, drillers, navvies, and foreman.....£2 15 0

Amount of material removed—average 10 tons per day.....4 9 per ton.

The above cases will be sufficient to show that with a mechanical substitute for blasting capable of exerting a total pressure of 150 or 200 tons upon rock, coal, concrete, masonry, etc., and in such manner as to cause no shock to the material in which it is operated, there should be possibilities of usefulness to engineers not previously contemplated.

Replying to the discussion, the speaker said that one speaker had referred to the use of black powder for blasting salt rock. That was really in line with the use of the hydraulic machine, which operated slowly and gradually. The old-fashioned explosives had the very distinct advantage that, owing to the length of time required before the gases attained their full temperature and pressure, it was possible to get the power exerted in a more effective way. He thought that if it were not for the element of danger associated with black powder, all users of explosives would agree that the old-fashioned slow-working explosives had always been most satisfactory. It was only carrying the principle a little further to apply it in the form of hydraulic power.

With regard to Mr. Jenkins' point, rotary drills had been used for making holes on many occasions, and it had been found that the diamond drill was quite satisfactory when used as a hand machine. It was very necessary to have a regular and smooth hole, and the diamond drill gave such a hole much better than any percussive drill could possibly do. It appeared to him that it would also have the effect of greatly reducing the amount of dust that would be made in the drilling of the hole, and not only would there be a smaller quantity of dust made, but that dust would be of coarser texture.

As to the driving of headings, he must say that in ordinary tunneling he had not been entirely successful, chiefly because of the difficulty of obtaining a suitable drill for putting holes in easily and quickly. It was not possible to blast from the solid. If the rock was to be broken with a loose end at all, it was necessary to be able to put in small holes readily and easily in various directions. Having loosened one side, there was then no longer any difficulty.

With regard to the limit of 150 to 200 tons, he mentioned those amounts because they were approximately

those to which he had worked up to the present. By using the 3-inch machine he got, with full pressure on, about 120 tons. When using a 4-inch machine he generally used about five pistons instead of eight, and he got 170 or 180 up to 200 tons pressure with that particular size. There was no limit. It was possible to increase the pressure according to the length and size



Fig. 10.—Hydraulic cartridge used in a bed of concrete.

of the machine, but there would arise a liability for the cartridge to become bent. There was no bending of the cartridge if the sizes of the machines used were limited as at present, provided that a regular hole was obtained. If the hole was not regular and smooth there would be the risk of some damage being done to the machine. He did not mean to say that there was a danger of bending the machine after the material had once been broken. When the back of the material was broken there was no danger to the cartridge. Very few machines had been bent or damaged in any way. That was probably due to limiting the length of the cartridge to 20 inches in the case of eight-piston machines and a few inches less in the case of a five-piston machine.

With regard to varying the intensity of the pressure, he thought that that was hardly necessary so long as the hole was drilled sufficiently deep. He did not like to have the end of the cartridge anywhere near the end of the hole. It should be right in. As long as it was right in the hole there did not seem to be any advantage to be gained by varying the pressure. He got the cartridge right into the hole, and then it was not necessary to make any change. Usually the pistons were out an equal distance throughout the full length of the cartridge, showing that the resistance had been the same throughout its length.

The Flight of a Golf Ball

SOME interesting statements concerning the flight of a golf ball were made in a case heard by Mr. Justice Warrington in the Chancery Court. The validity of the patent granted to William Taylor for his golf ball was challenged by Messrs. A. W. Gamage, Ltd., who claimed the revocation of the patent owned by Charles Stuart Cox and A. G. Spalding & Bros., who made the golf ball under the name of the "Dimple." In the specification of the patentee, he said his principal object was to obtain better results in the flight of the ball in the direction of a sustained hanging flight, giving a flat trajectory, with a slight rising tendency toward the end of the flight.

Prof. C. Vernon Boys said the form of the surface of the ball affected the flight very materially, and, from general experience, a smooth ball had been found not to be so good as one of which the surface had been roughed. The smooth ball had not an advantageous surface for getting a long travel. The character of marking which constituted Taylor's invention was an inverted bramble pattern, and consisted of isolated cavities, circular, evenly distributed, shallow, and their sides steep. Prof. Boys said he found by experiments that this form of surface gave an extremely satisfactory flight. The experiments consisted in driving the balls by means of a machine designed by himself and Mr. Taylor, and were carried out on Borstall Golf Course, on the road to Charnwood Forest. He did not find in the specifications of Willie Park and Fernie, on which Messrs. Gamage relied, Taylor's form of cavities.

In cross-examination as to the typical golf ball's flight, witness said the ball more than counteracted the action of gravity. His Lordship: The golf ball does not make a parabola? Prof. Boys: Not in the slightest degree; a good flight is very nearly straight for a long time, and then gradually rising and then falling. His Lordship, giving judgment, said that the main feature of the descriptive part of Taylor's specification was its vagueness. He held that the patent failed, and that there must be an order for its revocation. A stay was granted pending an appeal.—From the *English Mechanic*.

Snow Removal*

Report of the Conference Held in Philadelphia, April, 1914

EARLY in March, 1914, Mr. Morris L. Cooke, Director of the Department of Public Works, Philadelphia, wrote to a number of the leading eastern cities suggesting the needs of a conference on the subject of snow removal and pointed out, that in view of the very apparent lack of engineering methods generally employed in a problem which so clearly calls for engineering study, it might be profitable if those in charge of the matter of snow removal in the larger cities could be brought together, and that at least an approximation of a definite policy of snow removal might result from such a meeting. The suggestion met with such favor that a snow removal conference was held in Philadelphia on April 16 and 17, 1914.

A Committee on Resolutions, J. W. Paxton, chairman, was appointed to submit a report, which would be the result of papers, discussions and recommendations made at this conference, and the committee makes the following report:

The problem of snow removal must obviously be considered differently in different cities as its solution is dependent upon such variable elements as climate, population, width of streets, density and character of traffic, location of sewer systems, available disposal places and other local conditions, to say nothing of the financial policy of the municipality.

It would seem impossible to formulate anything but the most general suggestions, and yet it is found that even so vital a matter as the financial policy does not affect the main problem, except in the extent of the work.

The work of snow removal is generally done by contract under the supervision of city officials, payment being made according to the quantity removed as tallied by wagons hauling to the disposal dumps, the forces and equipment consisting of men with shovels, horses and wagons. In some cities, scrapers and plows are used to push the snow to the side of the street, relieving traffic and making it easy to pile, or to load without piling.

Salt is generally and very extensively used for the removal of snow in Liverpool, London, Paris and other European cities. The very general practice is to broadcast coarse salt on the streets during and immediately after a snow storm, and when the snow has been reduced to slush by the action of the salt, the streets are flushed with water and the slush washed down the sewers; but in those cities they do not have very heavy snows and it is doubtful whether it would be practicable here where we have a much greater depth of snow. There is also a very serious objection to the use of salt by the Societies for Prevention of Cruelty to Animals and in some of the cities it is prohibited by ordinance. It is questionable whether the use of salt has been given a fair trial in this country for the removal of snow and there is little doubt but that it would be useful in light snow storms.

Much thought has been given to the design of apparatus for melting snow, and also, to special machinery for scraping, loading and transporting. Inventors, designers and manufacturers should be encouraged to continue in the endeavor to produce equipment which will render practical and efficient service, but the amount of snow is so variable and the equipment is in use for such a short period of time that it is desirable it be designed to be useful for other work at different seasons of the year.

The problem confronting the public officials is the removal of snow in the shortest time in such a manner as not to interfere with traffic, and at a minimum cost. Therefore, using the method of scraping, shoveling into trucks or carts and hauling to dumps, the length of haul becomes a most important factor and it can readily be seen that the utilization of sewer manholes as dumps, and the sewer system to carry the material to the rivers, is the most economical method which can be devised as it reduces both the haul and the handling to a minimum. The authorities in charge of the sewer systems have, as a general thing, apprehensions regarding the use of the sewer as a snow carrier. The Borough of Manhattan, New York, Bureau of Sewers, however, made experiments during the winter of 1914 which seem to prove that, within certain limits, such apprehensions are ill-founded.

Gas and chemical combinations in the sewers have little effect on the rate of melting. Two cubic yards per minute is the maximum rate at which snow can be shoveled into a 24-inch manhole. Tidal sewers can only be used to advantage when the tide is low, in which case the factors of the ordinary sewer apply. Siphon sewers can be used as well as the ordinary type.

Where difficulty is experienced with an insufficient

flow in the sewers, or where the flow decreases or stops, the water plug may be opened in the drainage area of the sewer above the manhole in use, until the volume of water is sufficient to carry off the snow, but it has been found that the most efficient use of water may be had where water jets are constructed in the manholes into which the snow is dumped. The problem of getting the material into the manholes in the least time with the least interference with traffic opens up a field for the consideration of a special form of manhole to be used satisfactorily for this purpose. Pittsburgh and St. Louis both use a special form of manhole.

The committee gave further an account of the work of snow removal in the cities of Philadelphia, New York, Boston and Scranton, and also of the Public Service Railway of New Jersey, and the Pennsylvania Railroad Company, on which they base the following conclusions:

1st. The plan of organization and the system to be employed should be worked out in advance of the snow season. This preliminary work should involve: (a) a plan of co-operation among all branches of the municipal government; (b) the formation of a skeleton organization composed of all the available city forces, such as engineers, inspectors, time-keepers, laborers and teams; (c) the division of the city into zones and the determination of a definite method of work for each zone. The various members of the organization should be assigned to these zones and the responsible officials familiarized with the duties expected of them.

The character of work to be performed in the different zones may consist merely of the regulation of opening cross-walks and gutters and otherwise generally assisting pedestrian traffic and the run-off of the snow, or it may consist in the complete removal of the snow from the streets. Owing to the general increase in motor traffic and the concentration of business in definite office districts and to the general public demand for increased urban facilities, the present tendency is to increase the scope of the work involving the complete removal of snow from all main thoroughfares and business streets.

2nd. Removal work should commence as soon as the snow has covered the pavements and the indications point to the storm continuing, and should be carried on continuously. This as a principle is successfully followed by street railways and by some cities.

3rd. The carrying capacity of the sewer system should be utilized as far as possible.

The use of the sewers which reduces both the haul and handling to a minimum involves two operations: namely, getting the material to the catch basins or manholes, and then putting the material into the sewers. The first operation can best be done by loading into wagons or trucks and hauling to suitable manholes or by the use of scrapers or graders. The problem of getting the material into the manholes in the least time and with the least interference with traffic opens up a field for consideration of the question of special forms and special locations of manholes designed to be used solely for this purpose.

The method of flushing the snow with fire hose into catch basins may have a limited application but it is too unreliable to have any general value as it depends on weather conditions.

4th. When practicable, where there is only a small area to be cleaned, the work should be performed directly by the municipality by day labor. This method of operation is the most flexible and the most easily administered and it obviates the necessity of measurements and checking involved under the contract system. The work can also be performed by day labor in large areas by adopting the following method: The department to advertise and go out into the open market and hire teams to haul the snow for so much per yard, the price to be determined by the department and to represent a fair estimate of the cost of the work and a fair profit. This, of course, would throw the work open to anyone owning one team, or a hundred or a thousand or more teams, depending upon the amount of work to be performed, and would not leave the department dependent upon any one or more contractors. In this method, as well as when the work must be performed by contract system, a method of measurement as simple and accurate as possible should be used. The practicability of having work done by the municipality will depend among other things on the immediate availability of an appropriation. It is essential for the proper conduct of the work whether by day labor or contract that appropriation for snow removal should be made in advance of necessity for the work.

5th. Co-operation should be sought with the traction companies and use made of adjustable plows and sweepers

to open roadways adjacent to street railway tracks at the time that the work of clearing the tracks is being carried on.

6th. Effort should be made to obtain the co-operation of the public and to instruct the householders in the method of the removal of snow from private premises in such a way as to least impede the city's work. Where sidewalks are of greater width than would be necessary to handle the reduced volume of pedestrian traffic, which may be expected after a heavy snow, the snow instead of being entirely cleared from the sidewalk and piled in the roadway should be left on the sidewalk near the curb line to be later removed by the city when opportunity presents itself.

7th. The police force of the city should co-operate with the street cleaning force and the services of patrolmen as inspectors should be utilized as far as possible. The police in particular should give attention to the enforcement of regulation governing the removal of snow from the sidewalks or from a portion thereof.

In a written discussion Mr. J. T. Fetherston¹ remarked that New York City has tried almost every method of contracting for snow work, from the area system to the direct haulage method on vehicle capacity basis. Dividing the city into relatively small districts, larger districts and boroughs has been tried, and it would appear that the responsibility and experience of the contractor were of greater importance than the area or district assignments. In other words, an experienced contractor, with the nucleus of the necessary snow removal equipment, as a rule is in better shape to remove snow rapidly and control sub-contractors than is the municipality. More important still, he usually has sufficient control of funds to pay promptly all men employed. It would seem that experience, control of equipment and responsibility are the main factors to be considered, rather than the area basis, for the assignment of contracts.

The statement of general principles contained in the committee's report would be clarified if the work were separated into these divisions: (1) contract work, (2) street railway assignments, (3) municipal work. Necessarily under each head should be given the plan, and every reasonable contingency covered by the assignment of the most suitable means of snow removal adapted to particular areas, streets or districts of the city under consideration. All municipal departments should be called in to assist the street cleaning division by the assignment of officers for the supervision of contract work particularly, leaving the street cleaning department as free as possible to perform the work for which its own force is best fitted.

As a general comment on the committee report, it is suggested that, if possible, engineers or street cleaning officials should receive from an authoritative source, such as the society, a summary of conclusions covering:

(1) A statement as to what types of streets should be cleared of snow, and how far the municipality is justified in removing snow from minor thoroughfares at public expense.

(2) A statement setting up the reasonable depth of snow for which a municipality should have equipment available, and in general the time limits within which streets should be cleared, so as to avoid economic loss. Coupled with this, a maximum depth of snowfall beyond which all citizens and transporting agencies should be required to place their services at the disposal of the municipality at cost.

(3) A compilation of snow statistics for various parts of this country, and if possible a summary of attending weather conditions.

Each city must work out its own salvation regarding snow removal and disposal methods. The problem is so complicated by uncertainty as to weather conditions that no particular method is best fitted for all cities and all conditions.

E. D. Very,² in a written discussion, pointed out that an endeavor should be made to define the extent to which snow removal should be carried on in a municipality. This definition should not be made in units of mileage or of square yardage but rather in terms of necessity. In this regard the financial policy so affects the main problem as to deserve considerable study, as the extent to which the work shall be carried on depends largely upon the amount of money a municipality can afford to spend. This question must be answered before we may assume that the area to be cleaned has been decided upon and the appropriation of money must be predicated upon an understanding of the actual need in this regard. We should go further and discuss the manner in which funds for the work should be raised.

¹ Commissioner, Dept. of Street Cleaning, New York.

² Sanitary Engr., New York

* From the Journal of the Am. Society of Mechanical Engineers.

It is suggested that the tax for such purpose should be levied; a part by a general tax and a part by tax on property immediately benefited. Such a method would restrain the indiscriminate demand for unnecessary service for personal benefit.

W. Goldsmith³ called attention to a statement in the report where mention is made of enlarging manholes for the quick disposal of snow. In the Manhattan experiment it was shown that two cubic yards of snow per minute can be shoveled into a 24-inch manhole and that 2,500 cubic yards were dumped into one sewer by means of three manholes in an 8-hour day. This seems to indicate that a 24-inch manhole is large enough. Besides, the effect of an enlarged manhole on the pavement must be considered, the majority of defects in street surfaces being due to manholes of one nature or another and it seems that the elimination rather than an increase of these enemies to pavements should be striven for.

F. Kingsley pointed out the fact that the same old cart-and-horse methods for snow removal seem to be used that were adopted when the problem became serious some 20 years ago. It is interesting, however, to note the success of the snow-melting device on the Pennsylvania Railroad, because the melting of snow seems to be the most likely path along which improvement can take place.

The cost of fuel to melt snow is only some 15 per cent of cost of handling it under present methods. The basis for this is that a cubic yard of snow as removed weighs approximately 1,000 pounds and would require about 200,000 British thermal units to reduce it to water, allowing a liberal margin over the latent heat of ice. Coal at \$4 per ton provides about 67,000 British thermal units for one cent in a perfect furnace, or 27,000 British thermal units with 40 per cent furnace efficiency. At the latter rate the fuel cost for melting would only be 7½ cents per cubic yard or 15 per cent of the present apparent cost of handling it. This does not include interest or labor charges but these ought not to be insurmountable obstacles.

The problem is peculiarly one that mechanical engineers should be able to solve. It appears to be largely a balancing of the cost of heating surface against interest charges, and 1 square foot of heating surface can transmit heat (as demonstrated by existing locomotive boilers) at an approximate rate of 20,000 British thermal units per square foot per hour. With less efficient but more rapid transmission, twice this rate does not seem impossible. On this basis, apparatus capable of melting 100 cubic yards of snow an hour would require 500 square feet of heating surface. Certainly there is nothing abnormal involved in the provision of heating surface in such amounts as this.

One hundred cubic yards of compacted snow appears to be equivalent to about 450 cubic yards of snow as it falls, and in a 3-inch snowfall this amount would cover 500 linear feet of street. The subject obviously seems to be one that is worth consideration by the various cities in the country. It would be interesting to see some thoroughgoing experiments along this line.

The Protection of Iron and Steel by Paint Films⁴

By Norman A. Dubois

THE theories of corrosion of iron and steel which have received consideration and which still seem to have their defenders and opposers are interesting to note. The carbonic acid theory in brief requires the presence of carbonic acid to start corrosion. The peroxide theory supposes that hydrogen peroxide is formed in the presence of moisture and oxygen, and that this hydrogen peroxide causes corrosion. The electrolytic theory assumes that iron passes into solution in water in the form of a ferrous ion before it can oxidize. A more or less complete discussion of these theories may be found in the various journals and other publications. It is not the purpose of this paper to discuss them.

From the standpoint of the paint technologist the problem is that of finding the paint film which will enable him to protect the exposed surface of iron and steel from the various rusting influences for the longest possible time. The theories of corrosion and numerous discussions of them have been of inestimable value, and the proper interpretation of them has enabled the paint technologist to improve his paint film. Let us briefly consider these theories from the standpoint in question.

The carbonic acid theory requires the presence of carbonic acid that corrosion may proceed. In other words, considering a paint film properly applied over the surface of iron and steel it requires that carbon dioxide shall pass through this film, and also that water, either as such or in the form of aqueous vapor, shall pass through the film, and there in conjunction with the carbon dioxide react as carbonic acid. The

imperviousness of the paint film to carbon dioxide gas and to aqueous vapor, then, is the vital quality from the standpoint of this theory. The more impervious the paint film to the gases carbon dioxide and aqueous vapor, the longer it will protect the iron or steel from corrosion.

The peroxide theory requires the formation of hydrogen peroxide on the surface of the iron or steel. Considering a paint film properly applied over the surface of iron or steel, therefore, this means that the less pervious the paint film is to the gases oxygen and aqueous vapor, the smaller will be the quantity of hydrogen peroxide formed on the surface of the iron or steel, and the longer it will protect the iron or steel from corrosion.

The electrolytic theory requires that iron first pass into solution in water as ferrous ion, and that it is then acted upon by oxygen dissolved in the water or by carbon dioxide and water to form rust. Again considering a paint film properly applied over iron or steel this theory requires the presence of water in which the iron may dissolve to form ferrous ions. Obviously, the only way the water can get to the iron or steel is to pass through the paint film, as such, or in the form of aqueous vapor. If we suppose the ferrous ions have been formed, the action can go no further in the absence of an oxidizing agent, presumably oxygen, which in turn must get through the paint film. The reasoning for the presence of other gases is similar. We find, therefore, that for corrosion to proceed according to the electrolytic theory the gases, aqueous vapor, oxygen, or others must pass through the paint film, and, as in the other cases, the more impervious the paint film to gases and moisture, the longer it will protect the surface of the iron or steel from corrosion.

This is but to conclude that the paint film which will serve for the longest time as a protection to iron or steel against corrosion is the one which is the least pervious to aqueous vapor, the gases oxygen and carbon dioxide, or in fact any gas in the surrounding atmosphere which may in any way cause or accelerate corrosion.

If we assume the corrosion to be entirely due to the deterioration of the paint film rather than to its permeability to aqueous vapor and other gases, the same conclusion holds, as the rate of deterioration will be proportional to the permeability of the film to the deteriorating elements.

The electrolytic theory of corrosion has given rise to a division of pigments into three classes: corrosion accelerators, corrosion inhibitors, and inert. While these pigments seem to give results as predicted by this theory in the presence of an abundance of water or when the iron or steel is actually immersed in water, it does not necessarily follow that they will do so, to a like extent at least, when incorporated in a paint film where conditions are much different.

Assume, for instance, that our paint film is somewhat pervious to aqueous vapor and other gases. It follows that just as much moisture may enter to the iron or steel surface and perhaps give conditions under which the electrolytic theory may apply when outside conditions are damp, this moisture may also pass from the steel surface outward when outside conditions are dry, and thus leave the steel surface dry, in which case the electrolytic theory cannot possibly apply. As a matter of fact, the actual conditions existing on the surface beneath the paint film, in most instances, are very probably between the two extremes of somewhat damp and nearly dry, and this is far from being covered with an abundance of water at all times, the conditions under which the electrolytic theory seems to work out well. This reasoning is borne out by the fact that a piece of bright steel immersed in water containing a little zinc chromate in suspension will remain bright perhaps indefinitely, while the same pigment in a paint film under ordinary conditions will not protect the steel in a like manner.

Again, two paints composed of the same vehicle, but the first containing a so-called corrosion accelerator only, painted on a steel surface in a locality of ordinary dryness will outlast to a great extent the second containing a rust inhibitive pigment painted on a steel surface in a locality habitually very damp.

This reasoning seems to indicate and the evidence seems to bear out the conclusion that the problem of iron and steel preservation is rather to be solved by making our paint film as nearly impervious to gases as possible than by trying to prevent corrosion by the addition of the so-called inhibitive pigments.

The problem is a physical one rather than a chemical one, and a comparison of paint films as to their relative obstruction to the diffusion of gases will tell more regarding their value as protection against corrosion than a study of the inhibitive action of their pigments. This is not to say that the inhibitive property of certain pigments is not worth consideration, but the imperviousness of the films is of far greater importance.

A New Passenger Ropeway

THE methods of constructing ropeways have been so thoroughly perfected that large numbers have been built for the conveyance of both passengers and merchandise in various parts of the world and have proved entirely successful and satisfactory. A new installation that has recently been put into operation at Bozen, in Germany, is thus described: The way is 5,400 feet long, with a rise of 2,750 feet, the grade being an average inclination of 43 degrees. The up-and-down lines are located 20 feet apart and each consists of two steel cables, 20 inches apart, on which runs a four-wheel trolley. The cars, of which there are two, each with a capacity of sixteen people, half inside and half outside, are attached to these trolleys, and the two cars are connected by double cables operated by an electric motor located at the highest station. The current is derived from a central station, but there are batteries for use in an emergency, and hand gear is also fitted to the cars, one of which descends as the other ascends. This ropeway is supported on steel towers, the highest one being 56 feet, while the longest span between towers is 1,300 feet.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject matter involved, or of the specialized, technical, or scientific knowledge required therefor.

We also have associates throughout the world, who assist in the prosecution of patent and trade-mark applications filed in all countries foreign to the United States.

MUNN & Co.,
Patent Solicitors,
361 Broadway,
New York, N. Y.

Branch Office:

625 F Street, N. W.,
Washington, D. C.

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, MARCH 6, 1915

Published weekly by Munn & Company, Incorporated
Charles Allen Munn, President; Frederick Converse Beach,
Secretary; Orson D. Munn, Treasurer
all at 361 Broadway, New York

Entered at Post Office of New York, N. Y., as Second Class Matter
Copyright 1915 by Munn & Co., Inc.

The Scientific American Publications

Scientific American Supplement (established 1876) per year \$5.00
Scientific American (established 1845) " " 3.00
American Homes and Gardens " " 2.00

The combined subscription rates and rates to foreign countries,
including Canada, will be furnished upon application.
Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 361 Broadway, New York

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

Table of Contents

	PAGE
Personal Biologic Examinations.—By George M. Gould	146
Cultivation of Living Tissues Outside the Body	147
Experiments With Flying-boat Hulls.—By Carl Hawes Butman.—5 illustrations	148
Wheatstone Bridge for Resistance Thermometry	149
Snag Boats on Flood Rivers.—By Day Allen Willey.—4 illustrations	149
Diseases Dangerous at Different Periods of Life	150
Artificial Production of Vigorous Trees	150
Advantages of Surface Combustion	150
Electro-culture of the Soil	151
Records of Radio Time Signals.—By Prof. C. W. Wagner.—4 illustrations	152
Hydrogen, Its Technical Production and Uses.—By A. F. Seeker	153
Electric Waves and Oscillations.—By Dr. Gottlieb Leibach	154
German System and Method	155
The Government to Certify Timepieces	155
The Hydraulic Mining Cartridge.—By James Tonge.—10 illustrations	156
The Flight of a Golf Ball	158
Snow Removal	159
The Protection of Iron and Steel by Paint Films.—By Norman A. Dubois	160
A New Passenger Ropeway	160

³ Asst. Eng., Dept. of Public Works, New York City.

⁴ Reprinted from the *Journal of Industrial and Engineering Chemistry*.

ch 6, 1915

ve been so
have been
s and mer-
ave proved
installment
Bozen, in
5,400 feet
ing an aver-
down lines
of two steel
four-wheel
each with a
half outside,
o cars are
an electric
current in
e batteries
so fitted to
er ascends
the highest
reen towers

ve are in a
ery branch
s composed
erts, thor-
patent ap-
ure of the
technical

world, who
e-mark ap-
the United

,
ors,
adway,
York, N. Y.

CAN

3, 1915

rporated
erse Beach,

Class Matter

ms
er year \$5.00
" 3.00
" 3.00

n countries,
ocation
ft or check

New York

o publish
of distin-
cant arti-
tions, and
d thought
world.

PAGE
ould... 146
..... 147
Hawes
..... 148
..... 148
lley.—4
..... 149
..... 149
..... 150
..... 150
..... 151
F. Wag-
..... 152
y A. P.
..... 153
if Leim-
..... 154
..... 155
..... 155
ge.—10
..... 156
..... 156
..... 159
na.—By
..... 160
..... 160